September 8, 1958

Aviation Week

Including Space Technology

75 cents

A McGraw-Hill Publication

First Convair 600 Design Details

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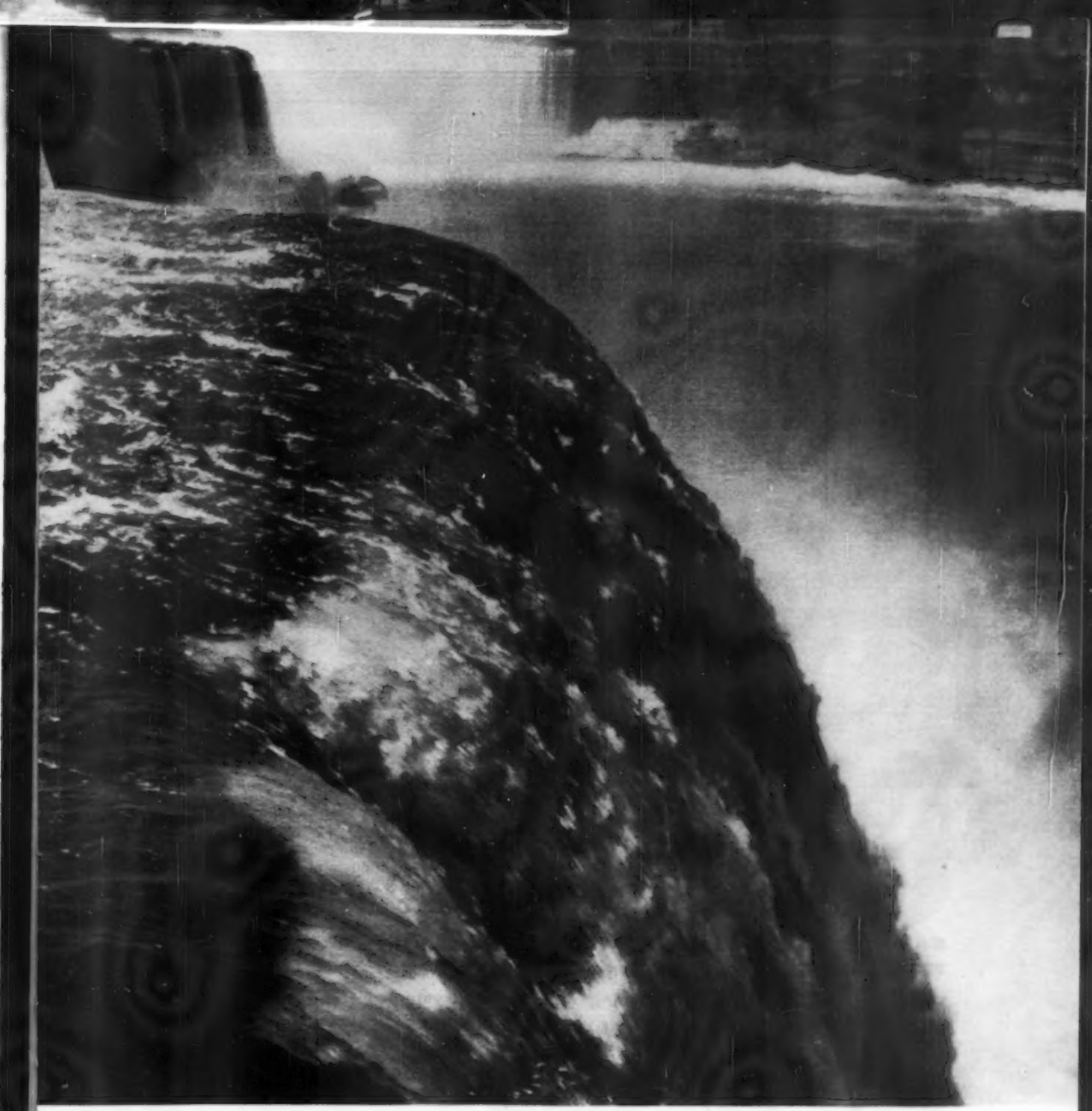
Special Report On Farnborough



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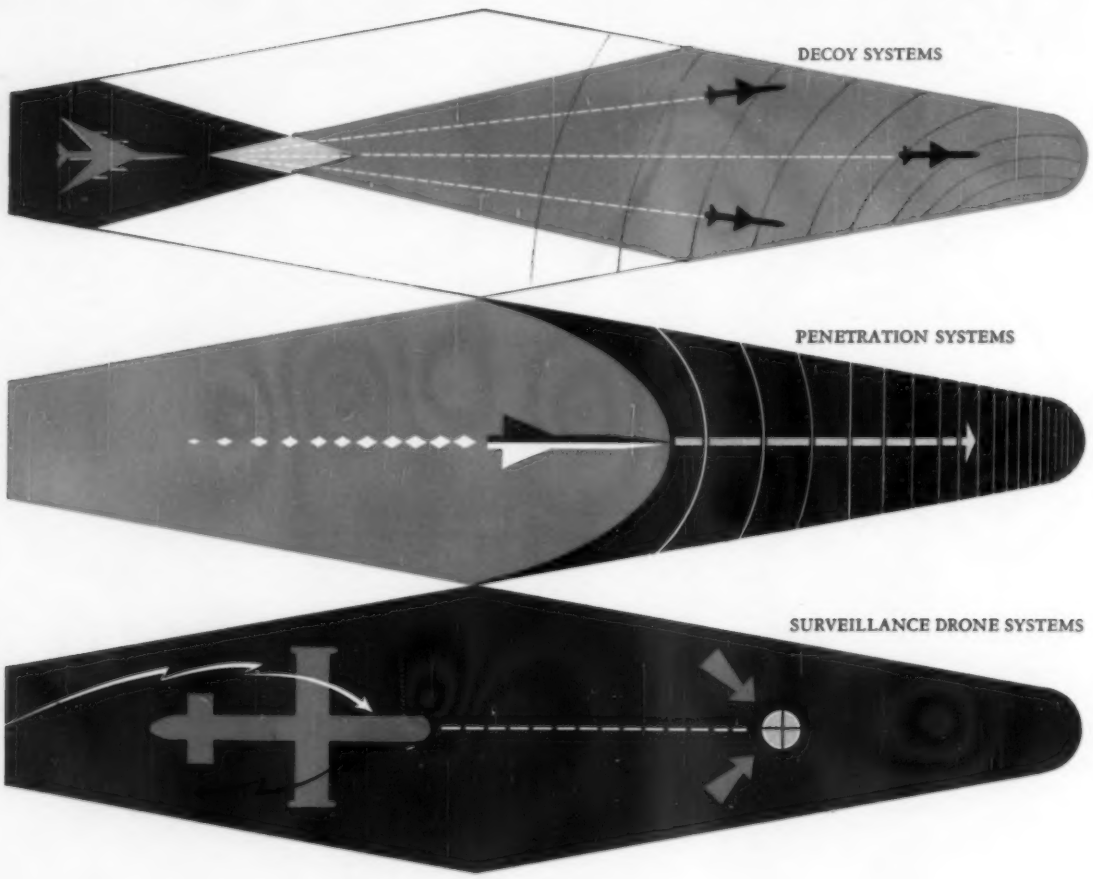

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Evaluation

Design

Development

Testing

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AVIATION CALENDAR

Sept. 8-13—First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid, Spain.

Sept. 11-12—Annual Business Meeting and Conference, Northeast Chapter, American Assn. of Airport Executives, Municipal Airport, Worcester, Mass.

Sept. 15-18—Fall Meeting, American Rocket Society, Inc., Hotel Statler, Detroit.

Sept. 15-19—Annual Instrument-Automation Conference & Exhibit (International) Instrument Society of America, Philadelphia Convention Hall, Philadelphia, Pa.

Sept. 22-24—1958 Convention of the National Business Aircraft Assn., Bellevue Stratford Hotel, Philadelphia, Pa.

Sept. 22-24—1958 Meeting, Professional Group on Telemetry and Remote Control, Americana Hotel, Bal Harbor, Miami Beach, Fla.

Sept. 23-25—Radio Technical Commission for Aeronautics, Fall Assembly Meeting, Chamberlain Hotel, Old Point Comfort, Ft. Monroe, Va.

Sept. 25-27—Fifth Annual National Western Forum, American Helicopter Society, Ambassador Hotel, Los Angeles, Calif.

Sept. 25-28—Air Force Assn. Annual Convention and Airpower Panorama, Dallas.

Sept. 29-30—Mid-Year Conference, Airport Operators Council, Mayo Hotel, Tulsa.

Sept. 20-Oct. 3—National Aeronautical Meeting, Society of Automotive Engineers, Ambassador, Los Angeles, Calif.

Sept. 29-Oct. 3—Semi-Annual Meeting and Western Tool Show, American Society of Tool Engineers, Shrine Exposition Hall, Los Angeles, Calif.

Oct. 1-3—National Airports Conference, University of Oklahoma, Norman, Okla. Co-sponsored by American Assn. of Airport Executives and the CAA.

Oct. 4—Second Annual Awards Banquet.

(Continued on page 6)

AVIATION WEEK Including Space Technology

September 8, 1958

Vol. 69, No. 10

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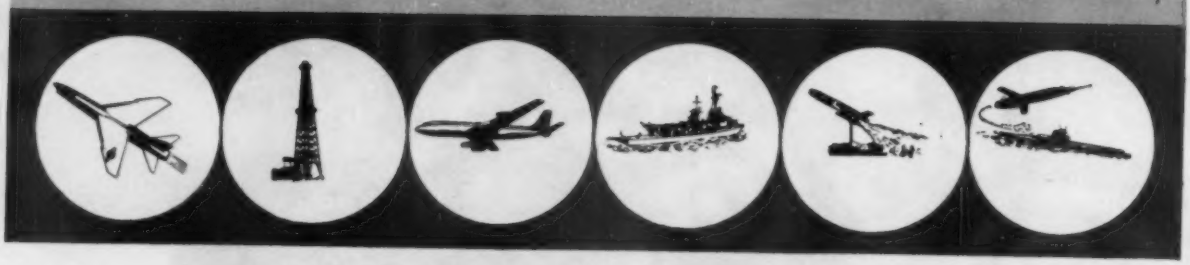

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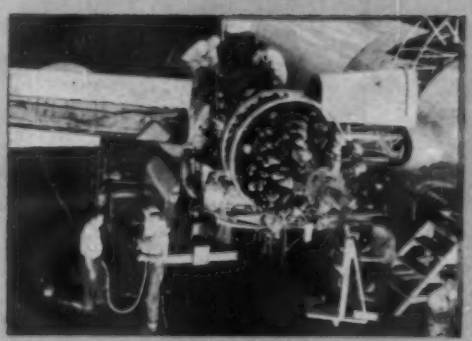
Accessory—Propeller Governors—Hamilton Standard, All Models; Woodward, All Models.
Magnetic Particle and Penetrant Inspection
Emergency Equipment—Life Vests, All Types and Models; Life Rafts, All Types and Models.



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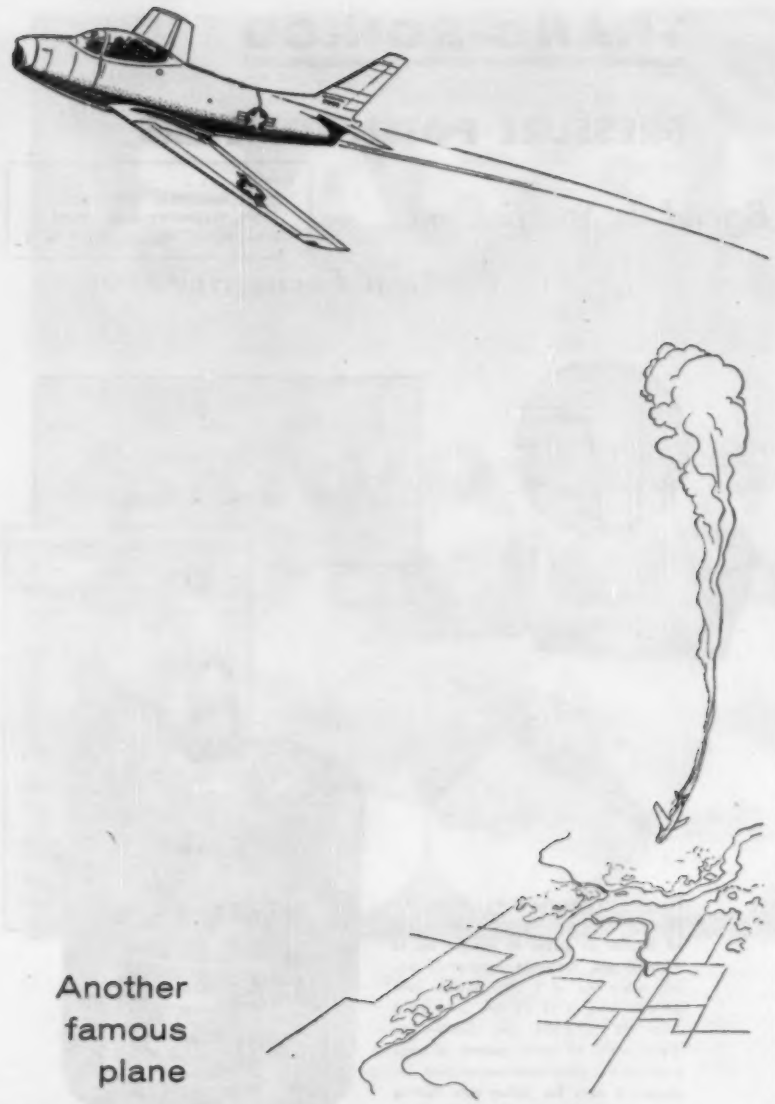

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AVIATION CALENDAR

(*Continued from page 5*)

Society of Experimental Test Pilots, Beverly Hilton Hotel, Beverly Hills, Calif.

Oct. 6-7—National Symposium on Extended Range and Space Transmission, sponsored by Institute of Radio Engineers and George Washington University, Lisner Auditorium, Washington, D. C.

Oct. 7-8—1958 Joint Meeting, Institute of the Aeronautical Sciences and Canadian Aeronautical Institute, Chateau Laurier, Ottawa, Canada.

Oct. 7-12—Sixth International Communications Convention, Genoa, Italy.

Oct. 8-10—14th Annual Aviation Spark Plug and Ignition Conference, Champion Spark Plug Co., Secor Hotel, Toledo.

Oct. 9-10—Ninth Annual National Noise Abatement Symposium, sponsored by Armour Research Foundation, Hotel Sherman, Chicago, Ill.

Oct. 13-15—ASME-ASLE Joint Lubrication Conference, Statler Hotel, Los Angeles, Calif.

Oct. 13-15—14th Annual National Electronics Conference, Hotel Sherman, Chicago, Ill.

Oct. 15-17—Twelfth Annual Meeting Southeastern Airport Managers' Assn., The Palm Beach Terrace, Palm Beach.

Oct. 20-21—Fourth National Aero-Com Symposium, sponsored by Institute of Radio Engineers, Hotel Utica, Utica, N. Y.

Oct. 20-22—1958 Annual Meeting, Assn. of the United States Army, Sheraton-Park Hotel, Washington, D. C.

Oct. 22-24—Fifth National Vacuum Symposium, Sir Francis Drake Hotel, San Francisco, Calif.

Oct. 23-25—1958 National Simulation Conference, sponsored by Institute of Radio Engineers Professional Group on Electronic Computers, Statler-Hilton Hotel, Dallas, Tex.

Oct. 27—14th Annual General Meeting of the International Air Transport Assn., New Delhi, India.

Oct. 27-28—East Coast Conference on Aeronautical & Navigational Electronics, Institute of Radio Engineers, Lord Baltimore Hotel, Baltimore, Md.

Oct. 30-31—1958 Electron Devices Meeting, sponsored by Institute of Radio Engineers, Shoreham Hotel, Washington, D. C.

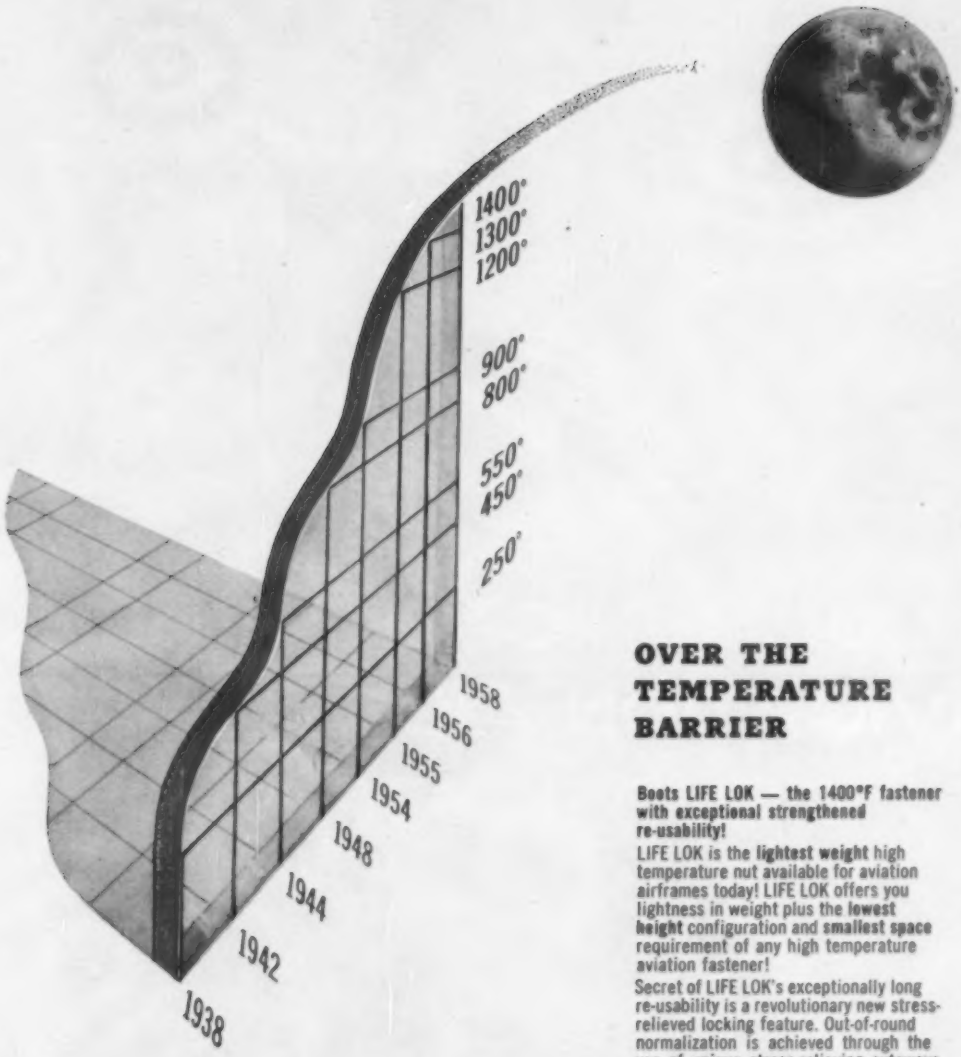
Nov. 6-7—Quarterly Regional Meeting, Assn. of Local & Territorial Airlines, Honolulu, Hawaii.

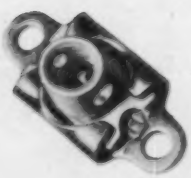
Nov. 6-7—Fifth Annual Meeting, Institute of Radio Engineers Professional Group on Nuclear Science, Villa Hotel, San Mateo, Calif.

Nov. 6-7—National Specialist Meeting on Dynamics and Aeroelasticity, sponsored by Institute of the Aeronautical Sciences Texas Section, Texas Hotel, Ft. Worth, Tex.

Nov. 10-13—11th Annual International Air Safety Seminar, Flight Safety Foundation in cooperation with Airways Modernization Board's National Aviation Facilities Experimental Center, Atlantic City, N. J.

Nov. 17-21—13th Annual Meeting and Astronautical Exposition, American Rocket Society, Hotel Statler, New York, N. Y.





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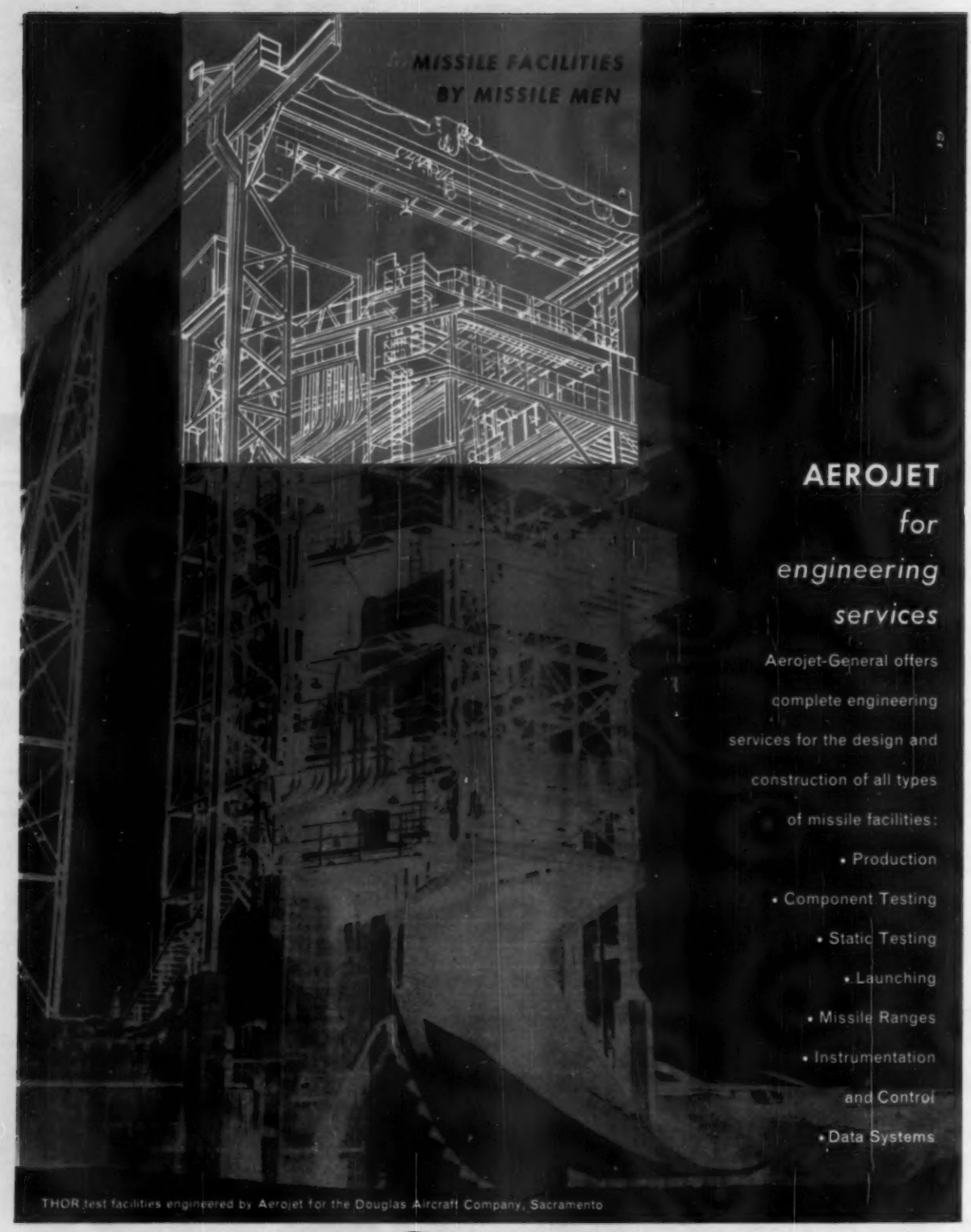

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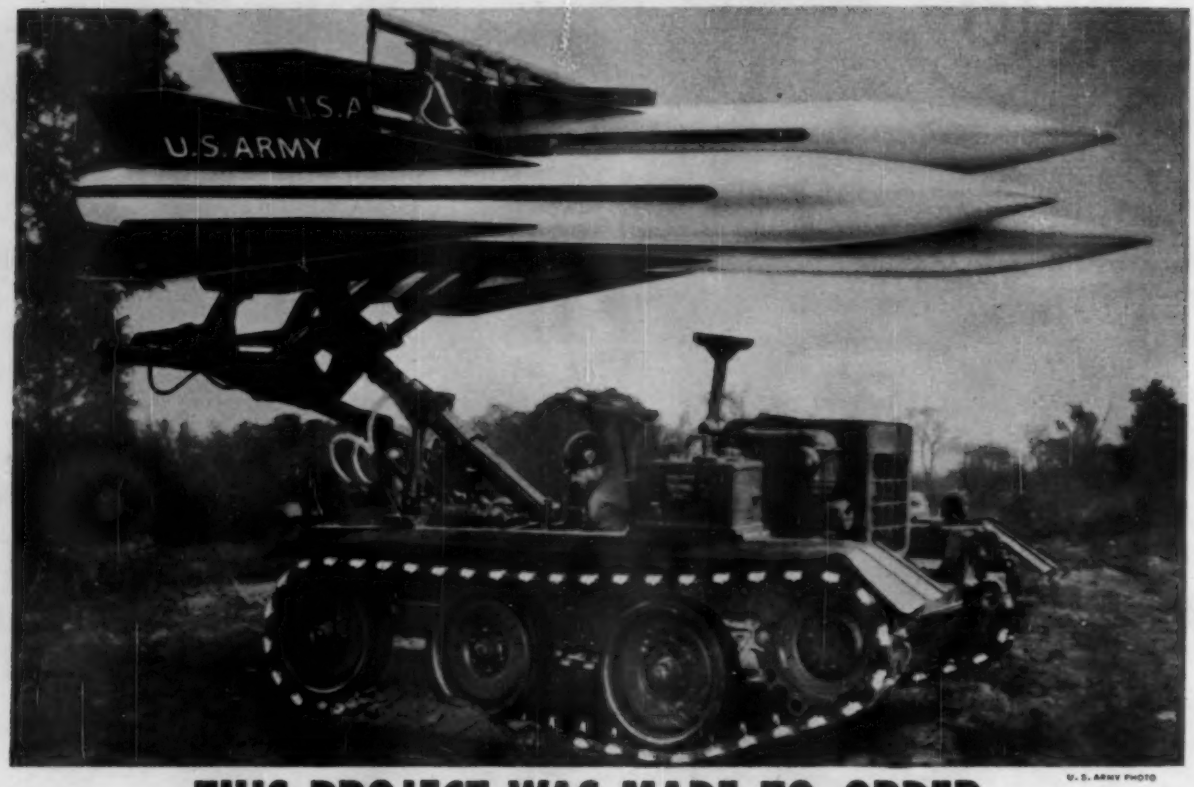

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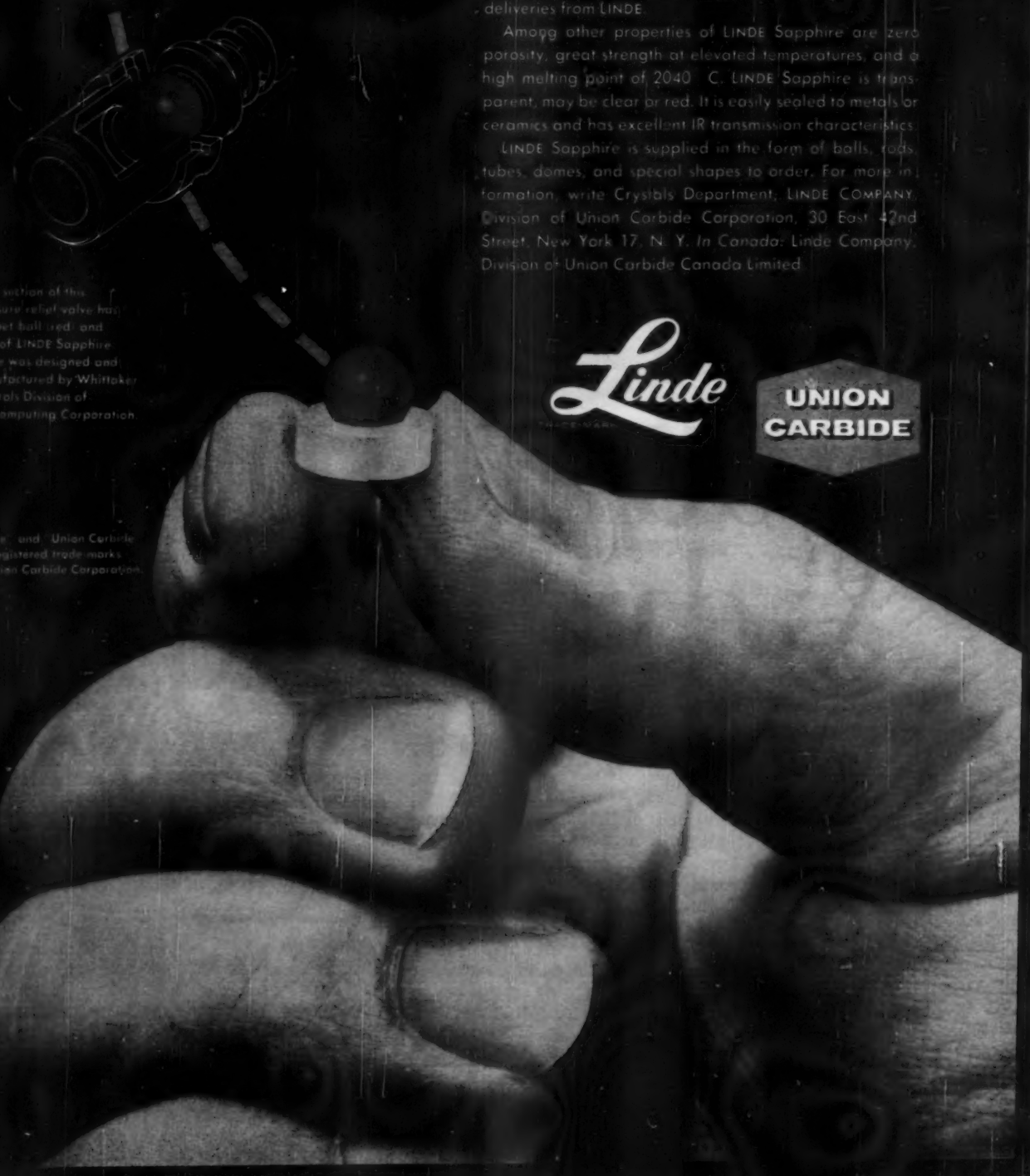
Linde UNION CARBIDE

Pilot section of this pressure relief valve has poppet ball (red) and seat of LINDE Sapphire. Valve was designed and manufactured by Whittaker Controls Division of Telecomputing Corporation.



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New—from Timken Company Research...

TBS 600

a thru-hardening steel

CBS 600

a carburizing steel

...for bearing and aircraft use at temperatures up to 600° F.

TO meet the increasing temperatures of jet and rocket craft, The Timken Roller Bearing Company has developed two new low alloy steels with high recovered hardness and good resistance to tempering for operation up to 600° F. These steels are especially suited to anti-friction bearings as well as other aircraft and missile uses. They have been thoroughly tested under simulated service conditions and are available in the form of seamless tubing, bar stock, bars and billets, and ball or roller wire.

The thru-hardening steel—Timken TBS 600 steel—has a recovered hardness of 59 Rockwell C measured at room temperature after holding 500 hours at 600° F. Hot hardness at 600° F. is 56 Rockwell C which is extremely high for a low alloy steel.

The carburizing steel—Timken CBS 600 steel—exhibits a hot hardness of 56 Rockwell C and a recovered hardness of 61 after 500 hours at 600° F., at the 1% carbon level. Corresponding hardness for the core is 55 and 58 Rockwell C. Both steels contain less than 5% alloying elements.

TBS 600 and CBS 600 can be machined and heat treated in practically the same way as their normally used counterparts. For more information call or write: The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

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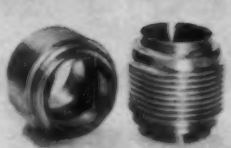
Compare all these factors



PRODUCT	TIE-ROD	GIMBAL JOINT	PIN JOINT
TENSION MEMBER	Struts and linkage	Gimbal ring	Side pin hinge
ENVELOPE SIZE	Smallest	Largest	Medium
WEIGHT	Low	Heavier	Low
PRESSURE DROP	Approx. 7x△P St. Tube	Approx. 3x△P St. Tube	Approx. 2½x△P St. Tube
FLEXIBILITY	Angular movement in all directions.	Angular movement in all directions.	Movement in one plane only. Absorbs load on axis perpendicular to deflection.
DEFLECTION FORCE	Lowest	Low	Low

The relationships above will vary with combined factors of temperature, pressure and size.
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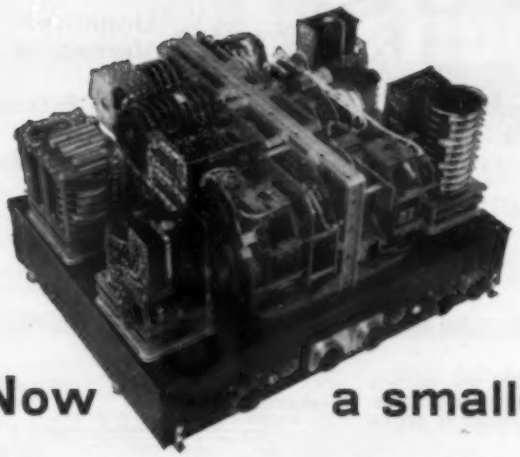

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September 8, 1958

Aviation Week

Including Space Technology

Vol. 69, No. 10
Member ABP and ABC

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COVER: Just 77 sec. after launching, this Thor-Able lunar probe test vehicle exploded and fell into the Atlantic Ocean about 10 mi. offshore from Cape Canaveral, Fla. Explosion in Thor first stage engine may have been caused by ruptured fuel or liquid oxygen line (AW Aug. 25, p. 21). Lunar probe vehicle reached 50,000 ft.; in another 80 sec. the Thor's Rocketdyne engine would have reached burnout. For other pictures of Cape Canaveral activities, see pages 62 and 63. Air Force plans another shot next week.

PICTURE CREDITS

Cover, 62, 63—USAF; 26, 27, 28, 29, 30, 31—Russell Melcher; 32, 34—Kaman Aircraft; 33—North American Aviation; 37—World News; 44, 45—de Havilland; 50, 51, 53—Convair; 59—Saunders-Roe; 64—Stanford University; 65—(top) Bell Telephone Laboratories; 65—General Electric; 76—Chance Vought; 77—Burton Kemp.

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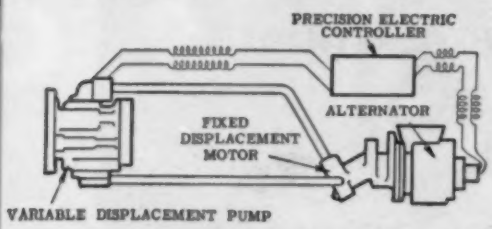

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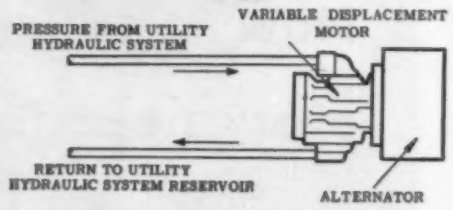

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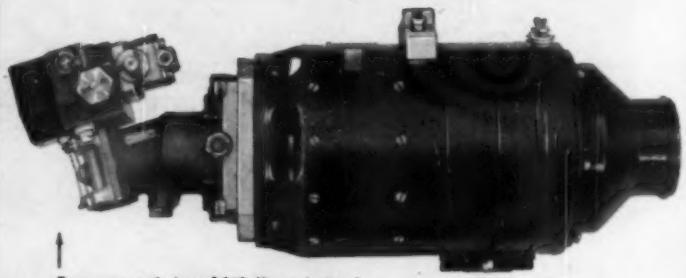

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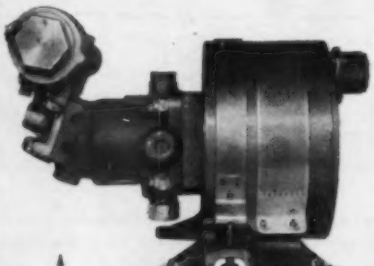

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EDITORIAL

A Decade of Farnborough

It is just ten years since Farnborough Airdrome became the showcase for the British aviation industry and the Society of British Aircraft Constructors flying display crystallized into its present format. With the roar of the turbojets and rockets of 1958 vintage aircraft still ringing in our ears and the warm hospitality of the striped caravans a pleasantly fresh memory, it seems appropriate to look back over the decade-long history of this remarkable aviation tradition and the industry it serves.

Main purpose of the show is to sell aircraft abroad. Export sales are the lifeblood of the British economy. In this vital area the British aircraft industry has made a significant contribution during the Farnborough decade. It is now heading for the largest export sales in its postwar history with a total close to a half billion dollars in sight for 1958. This compares with about $325 million in export sales for 1957 and is about five times the foreign sales volume of 1948 when the fanfare began at Farnborough.

Excellent Aerobatics

In addition to foreign sales, the show produces some of the finest flying ever seen. The individual virtuosity of the post-war crop of British test pilots exhibiting their new prototypes is a sight that Farnborough spectators will never forget.

This year was no exception in the flying department. The black Hawker Hunters flown by pilots of the Royal Air Force 111 Squadron performed a precise aerial strip tease hatched by the fertile brain of their commander, Squadron Leader Roger Topp. Beginning with a perfect tight formation of 22 planes 111 Squadron executed two loops without altering their formation an iota. Then the strip tease began with six planes peeling off while the remainder went into a tight V and did a pair of formation rolls followed by another peel off of seven planes. This process continued until a bombburst maneuver peeled off the final four surplus planes leaving the squadron stripped to its famous five plane acrobatic formation that completed the routine made famous at the Paris air show last year. It was a most original and precisely flown operation.

Helicopter Ballet

Also outstanding was the helicopter ballet flown by a quartet of Westland's pilots before the delighted eyes of Mr. Igor Sikorsky on whose designs the Westland products are based. Ranging from the huge skeleton of the Westminster to the relatively tiny five passenger Wigdeon, the Westland quartet traced an intricate ballet of maneuver across the airdrome. Particularly lively was the performance of the turbine-powered Wessex whose pilot twice went over around the top of a loop. The LABS bombing maneuvers of the huge Avro Vulcan delta wing bomber and the Handley Page Victor were also sights not soon to be forgotten.

As our European Editor David Anderton has reported on p. 26 there was an air of sober reflection at Farnborough 1958 in contrast to the enthusiastic salesmanship of earlier years. While the British aviation industry is now harvesting the crop of record export sales sown in the early 1950s, it is facing some grave problems in the future. It is obvious now that the British government swallowed too quicky the myth that guided missiles would quickly make all the manned aircraft obsolete. Although we initially made the same mistake, a more realistic policy has prevailed in U. S. military aircraft development for the past few years. But in Britain this reappraisal has not yet taken place although for economic reasons there may be no other choice than trying to wait for missiles to achieve operational reliability. Britain's first generation of missiles, primarily air to air and ground to air, do not seem headed for any significant export volume. The British missiles now coming into production and service are technically a generation behind and are not likely to compete successfully with the generation of atomic-tipped missiles now in early operational use with the U. S. Army and Air Force.

There is another generation of British gas turbine-powered transports nearing completion in prototype form including the Vickers Vanguard, Handley Page Herald, and Armstrong Whitworth Argosy.

But there is as yet no indication that any of them will come anywhere near matching the record sales run of the Vickers Viscount, Rolls-Royce Dart combination. Beyond this crop of transport prototypes is another group of new jet transport designs. But it is far too early to assess their commercial sales prospects now. There is no doubt, however, that the financial plight of airlines around the world is going to pose a serious sales problem for British products just as it is casting a cloud on the future order books of Douglas, Lockheed, Boeing and Convair.

Logistics Lessons

It seems a pity, with the mobility lessons of Suez and Lebanon so plain, that there still is no real effort to build a British military aerial logistics system based on the new generations of gas turbine-powered transports that could so easily be available. British military power is bound to suffer severely in the future from this perennial neglect of modern air transport. This is an area in which our own military planners have not displayed any shining brilliance but our neglect is one of degree which still leaves us with considerable airlift capability rather than the almost total neglect that characterizes British military transport policy.

There is little doubt, looking back over the past ten years that Farnborough has done a superb job as the showcase for the British aircraft industry. But a showcase can only perform its function when amply filled with salable goods. There is little doubt that the British aviation industry will have to tax its technical ingenuity, financial resources and production capacity to the utmost in the critical years now upon it in order to keep the Farnborough showcase as well stocked with exportable products in the next decade as it was in the last.

—Robert Hotz

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WHO'S WHERE

In the Front Office

Hector Font Viale-Rigo succeeds **Col. Antonio Briceno Linares** as president, LAV, The Venezuelan Airline.

W. J. Pattison and **Harry Wetzel**, vice presidents, The Garrett Corp., Los Angeles, Calif. Mr. Pattison will be in charge of sales for the AiResearch Manufacturing Divisions, Los Angeles and Phoenix; Mr. Wetzel continues as manager of the AiResearch Manufacturing Division.

H. J. Chase, vice president-maintenance operations, and **D. O. Wood**, vice president-engineering and research, Lockheed Aircraft Service, Inc., Ontario, Calif.

Everett M. Patterson, vice president-industrial and defense sales, Bulova Watch Company, Inc., Jackson Heights, N. Y. Mr. Patterson continues as president and a director of Bulova Research and Development Laboratories, Inc.

Air Vice-Marshal Glynn Silyn-Roberts will become Royal Air Force's Director-General of engineering. **Air Commodore Maxwell Perkins** will replace Vice-Marshal Silyn-Roberts as the Bomber Command's Senior Technical Staff Officer.

Clyde Skeen, assistant general manager, Systems Management Office, Boeing Airplane Co., Seattle, Wash. **J. O. Yeasting**, vice president-finance, assumes Mr. Skeen's former duties as controller; **Carl E. Dillon** will assist Mr. Yeasting as assistant controller. Also: **Ben Wheat**, director of finance, Wichita Division; **C. R. Bumgardner, Jr.**, succeeds Mr. Wheat as Transport Division controller, Seattle.

Honors and Elections

Dr. John F. Victory, The National Advisory Committee for Aeronautics' Executive Secretary and its first employe, has received the Committee's highest award, its Distinguished Service Medal.

Changes

R. M. Osborn, project engineer, Autonetics Division of North American Aviation, Inc., Downey, Calif.

Dr. Martin J. Gould, chief of electronics research, Bell Helicopter Corp., Fort Worth.

Walter Clark, manager, The Garrett Corp.'s Air Cruisers Division, Belmar, N. J.

Raymond A. McElvogue, propellant plant manager, Longhorn Division, Thiokol Chemical Corp., Marshall, Tex. **John H. Sims** succeeds Mr. McElvogue as chief engineer, Rocket Engineering Department. Also: **John T. Kerr**, chief product engineer, Rocket Engineering Department, and **H. C. Havron**, chief, Quality Control Department.

James H. Reid, chief engineer, Subsystems Division, Servomechanisms, Inc., Hawthorne, Calif.

Mervin Bagan, assistant to the president, Los Angeles Airways, Inc., Los Angeles, Calif. Mr. Bagan was formerly associated with the Civil Aeronautics Board.

David S. Haxton, general superintendent-manufacturing, Rocketdyne, a division of North American Aviation, Inc., Canoga Park, Calif.

INDUSTRY OBSERVER

► Soviets are developing a 75-mi.-range air-to-air interceptor missile that operates as a beam rider until it reaches the vicinity of its target. Missile apparently is guided on final leg to target by an internal homing device.

► **Reaction Motor's XLR-99 liquid rocket engine for North American Aviation's X-15 high-altitude research aircraft is now on the test stand at Edwards AFB, Calif., rocket base.**

► Soviet pilots are performing toss bombing maneuvers without the aid of any type of autopilot or special bombing system, according to Russian Air Force journals. Pilots are given an initial point over which to fly plus a heading to follow and then must perform a very precise pull-up maneuver and release their bombs at the proper instant to achieve accuracy.

► **New single-place 65 hp. lightplane built by Schweizer Aircraft Corp., Elmira, N. Y., (AW June 23, p. 15) has shown excellent performance in early flight tests, including takeoff in approximately 75 ft. Plane is capable of "football-field" type operation, features a Schweizer 1-26 sailplane wing with spoiler system. Indications are that the new lightplane may be the first of a family of powered, low-cost aircraft planned by Schweizer to supplement its sailplane production. On the drawing boards is a light cargo type designed around a 320 hp. Lycoming engine.**

► Mooney Aircraft Co. is flying a prototype Mark 20B with a 250 hp. engine and plans to have the new aircraft in production by next summer. Latest in the Mark 20 series, the 20B is in the 200 mph. class, has a range of over 1,000 mi. and probably will sell for $18,200. Engine is a Lycoming 0-540.

► **Russians are employing a second complex for launching intercontinental ballistic missiles to the east of the present Kapustin Yar facility (AW Oct. 21, p. 26).**

► Strategic Air Command reportedly is interested in establishing monorail systems to carry personnel and supplies between its dispersed bomber and fighter sites.

► **Sales battle between Lockheed F-104 Starfighter and Grumman F11F-1F Super Tiger to Japan is continuing even though Japanese Defense Agency says the decision to purchase the Super Tiger is firm. Lockheed's latest unit price, reportedly for the day fighter version of the F-104, is $755,000. Grumman has quoted a lower price for an all-weather Super Tiger.**

► U. S. soaring experts believe Russians are making a concerted effort in the design of high-performance gliders in an effort to capture the leadership in this field. Members of the U. S. team participating in the recent international soaring meet in Poland noted that the Russians flew borrowed sailplanes, warned "wait until 1960." Although it is not generally realized, most of the important sailplane height and distance records are now held by the U. S.

► **First zero launch by Air Force of a North American F-100 was made recently from Edwards AFB, Calif. Pilot for the flight was Capt. Robert Titus. Previous zero launches with the F-100 were made by North American engineering test pilot A. W. Blackburn.**

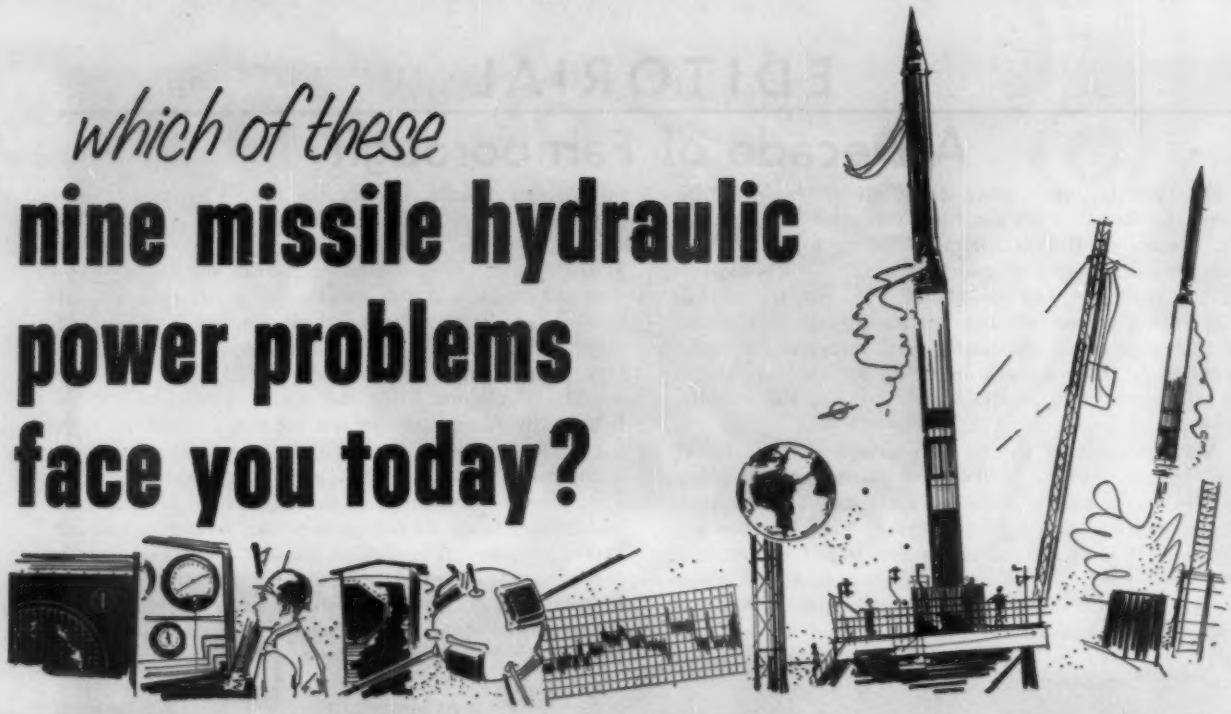
► Sud Aviation is designing a new, large turbine-powered helicopter.

► **North American Aviation has awarded a subcontract to the John J. Foster Manufacturing Co., Costa Mesa, Calif., for honeycomb structures for the B-70 Mach 3 bomber project.**

► Navy plans construction of a $10 million assembly facility for the Polaris fleet ballistic missile at the Naval Ammunition Depot, Charleston, S. C. Construction is scheduled to begin this fall.

which of these

nine missile hydraulic power problems face you today?



PROBLEM

weight and space Eastern hydraulic power units are made of *miniature* high-speed gear pumps, close-coupled directly to performance-tested electric motors. Even when components are added such as reservoir, expansion-relief valve, expansion bellows, adjustable pressure-regulating valve, check valves — total weight is under 5 pounds, size only 7¾" x 2¾" x 7½" (Eastern unit illustrated used as example).

PROBLEM

high temperatures Most Eastern units normally operate at temperature range of −67°F. to +220°F. Higher temperature limits are no problem.

PROBLEM

reliability The necessity for high performance and reliability in executing commands of the guidance system, makes hydraulic systems a vital link in performance. Eastern systems have gained the reputation for outstanding reliability under extreme environmental conditions when operating at high speeds.

PROBLEM

high-speed power take-off Eastern gear pumps with speeds of 24,000 RPM permit direct drive by main power source.

PROBLEM

complicated, heavy plumbing Running lines from power unit to remote areas can be eliminated by using individual self-contained hydraulic power units at each point. You gain maximum flexibility, simplicity, reliability, while removing more weight in plumbing than you add in power packs.

PROBLEM

compromised accessory performance When all accessories adapt the 3000 PSI main system pressure by means of power-wasting, heat-producing, pressure-reducing valves, performance suffers. Eastern units offer individually selected hydraulic fluids and pressures to give optimum performance to each accessory in the system. Eastern units have capacity to 1.5 GPM at pressures to 3000 PSI.

Eastern Aviation Bulletin 350 provides a wealth of performance data. Request your personal copy today.

PROBLEM

fluid contamination System cleanliness is insured by a sealed system and continuous filtering of pump discharge.

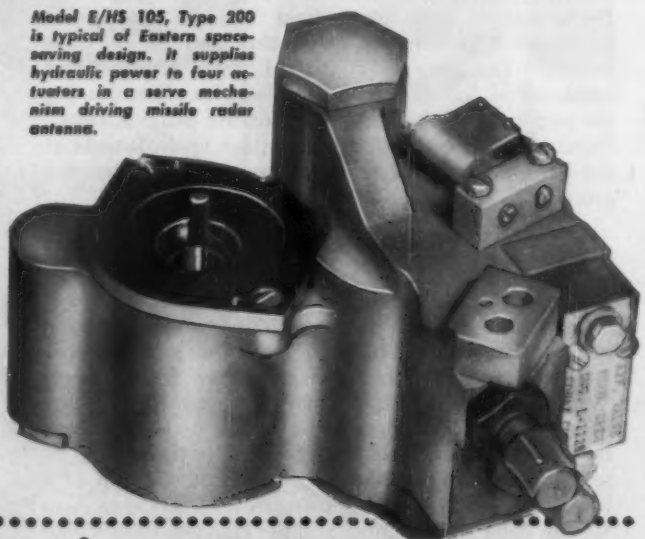
PROBLEM

runaway costs Eastern uses standard mass-produced components, arranges them to match your space, to give you a custom design with minimum development expense.

PROBLEM

divided responsibility Eastern welcomes the opportunity to develop components or complete missile subsystems in hydraulic power, electronic cooling and refrigeration, and pressurization. Design and manufacturing responsibility from one experienced source is your assurance of dependable performance. Write, phone, wire for complete information.

Model E/HS 105, Type 200 is typical of Eastern space-saving design. It supplies hydraulic power to four actuators in a servo mechanism driving missile radar antenna.



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Washington Roundup

European Missile Facilities

Facilities for the production of advanced missiles and aircraft for NATO countries will be established in Europe and financed by the Defense Department if present plans are carried out.

A European delegation is expected to visit the U. S. in the near future to inspect production facilities and meet Pentagon officials in conferences in an effort to determine which types should be produced in Europe. Among the countries that will be represented in the delegation are Holland, West Germany, France and Italy. The U.S. will supply technical assistance in the construction of facilities and organization of production.

Abandoned Attempt

Efforts to publish a book and magazine article reporting to the general public, within bounds of security, the basic contents of the Gaither Report have been abandoned. The report remains classified "White House Top Secret" and is not available even to those with ordinary "Top Secret" and "Q" security clearances.

The report tells in great detail what the military, economic, technological, ideological and subversive threats of Soviet power are and what the U. S. must do to meet them. Some members of the Gaither Committee which prepared the report have strongly indicated that the basic information must be disseminated to the public if the U. S. is to take the necessary steps for survival.

Willing Candidates

Defense Department is having difficulty in finding a willing top-level candidate to fill the post of Director of Defense Research and Engineering, scheduled to become the Defense Secretary's principal assistant on scientific and technical matters under present reorganization plans. Several persons already approached have declined. Administration may turn to Roy Johnson, possibly asking him to wear two hats, retaining his present post as head of the Advanced Research Projects Agency.

Airport Aid Outlook

Despite veto of the Federal Aid to Airports bill and the Administration's desire to phase out the program, chances are good that the next Congress will again approve expansion of the program or increase funds for this purpose. The program not only has strong Congressional backing, but has enthusiastic support from influential civic organizations throughout the country.

Space Proposal

U. S. proposals for international cooperation in the exploration of outer space are being finalized under State Department supervision before presentation at the next session of the United Nations General Assembly.

Henry Cabot Lodge, U.S. representative to the U.N., said in Chicago last week that the President had instructed him to formally present the plan which is designed to benefit the world's entire population. The State Department here said proposals had been under consideration since the first of the year and that the program would include detailed plans for international cooperation on such projects where new space knowledge could be applied to medicine, communications, transportation and weather.

The program is being prepared by a little-known "unofficial committee" of top government officials working under State Department auspices.

Atoms Conference

Results of the first week of the United Nations "Atoms-for-Peace Conference" in Geneva have bolstered the hopes of Atomic Energy Commission officials here for effective future cooperation between the U. S. and Russia in developing thermonuclear power.

Russian and U. S. scientists have joined scientists of 44 other nations in a realistic discussion of their work to develop an economic thermonuclear power plant. The conference, which ends Sept. 13, has scheduled 77 separate sessions on all aspects of peaceful atomic research from health to the production for power. AEC officials say the cooperative attitude prevailing during the first week has brightened prospects for effective cooperation in the future.

Election Prospects

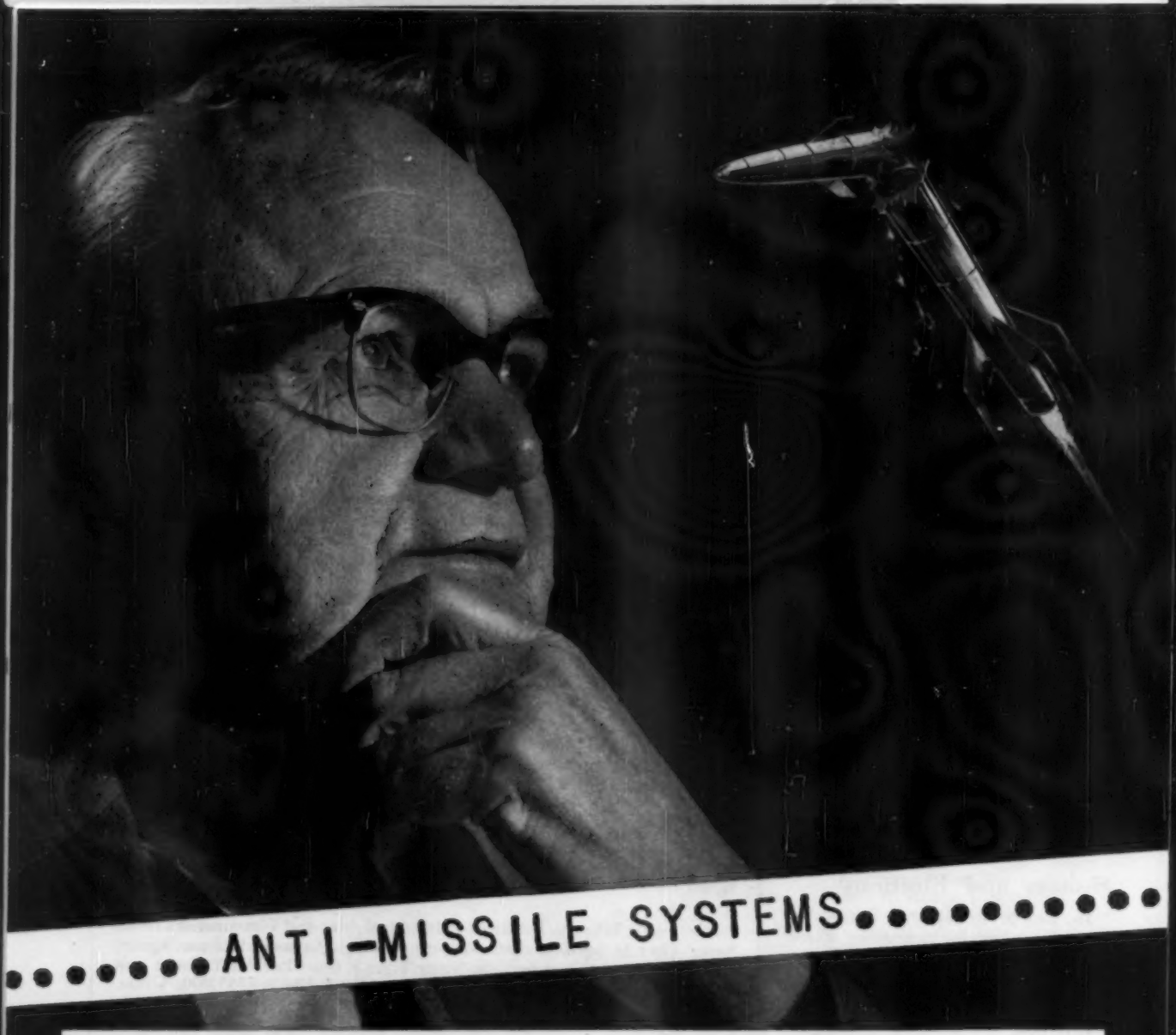
Prospects look good for most U.S. senators facing re-election this November who have been active in aviation matters. These include:

- **Sen. Stuart Symington (D.-Mo.),** former Secretary of the Air Force and a member of Armed Services Committee, is considered the likely winner in a race with Miss Hazel Palmer, attorney and former national president of the Business and Professional Women's Club, the Republican candidate.
- **Sen. Henry Jackson (D.-Wash.),** chairman of the Joint Atomic Energy Subcommittee on Military Applications and a member of the Armed Services Committee, is expected to win easily over his Republican opponent, William Bantz, former prosecuting attorney of Spokane.
- **Sen. Frederick Payne (R.-Me.),** a member of the Senate Commerce Aviation Subcommittee, is in a close race with Maine's Democratic governor, Edmund Muskie.
- **Sen. John Bricker (R.-Ohio),** ranking Republican member of Senate Commerce Committee, is generally considered to have the advantage over Stephen Young, former congressman.

ALPA-American Dispute

Airline pilots are not expected to give much ground in their dispute with American Airlines despite criticism last week in an Emergency Board's report to President Eisenhower that the Airline Pilots Assn. group had made only one significant "but belated" counter proposal against certain company proposals which increased its offer to the pilots. The Board, which concluded hearings Aug. 8, recommended a continuance of bargaining between the two negotiating committees. Last week, it told the President that progress in the negotiations had been "unsatisfactory" and charged the pilots with making a set of demands greater than had made known to either the Board or the company. Stating that there had been no realistic bargaining of the issues involved, the Board recommended that hearings be dropped and that negotiations between the company and the pilot group be resumed in "an atmosphere devoid of mutual suspicion. . . ."

—Washington staff



ANTI-MISSILE SYSTEMS

A Research Project of Dr. Harry Nyquist, Senior Scientist, Stavid Engineering, Inc.

Dr. Nyquist is a pioneer in advanced areas of electronics such as Information Theory and circuit noise, and is credited with nearly 150 patents in the field of communications. He is now contributing his exceptional analytical ability to Stavid's work on a far reaching anti-missile system. Men like Dr. Nyquist are typical of Stavid's outstanding scientists and engineers who are working on advanced concepts . . . years ahead of actual systems development.

In Stavid's objective engineering atmosphere, scientific, development and manufacturing teams are producing a wide range of electronic systems for all branches of the military. Typical of such projects is the REGULUS missile command guidance system, designed, built and maintained in operational status by Stavid.

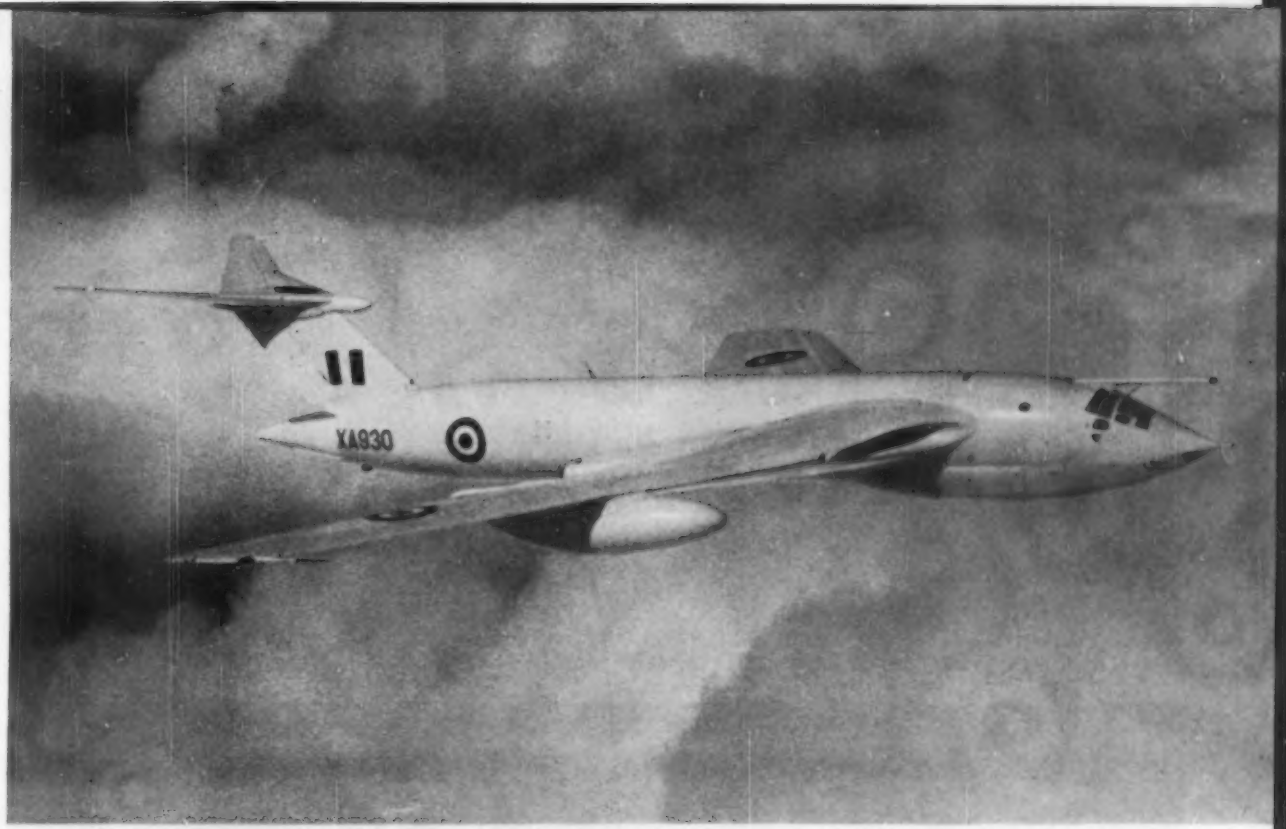
CURRENT STAVID PROJECTS INCLUDE:

- Airborne Search, Bombing and Terrain Clearance Radar
- Radar-Infrared Airborne Fire Control System
- Missile Beacon Telemetering System
- Missile Guidance Systems
- Anti-Aircraft Subminiature Fire Control System
- High Power Air Search Radar

STAVID Engineering, Inc. Plainfield, New Jersey.

Imaginative Electronics . . .

Engineers and Scientists: Join Stavid's Advanced Systems Engineering Team.



HANDLEY PAGE VICTOR heavy bomber appears in new version fitted with aerial refueling probe protruding from above the cockpit and larger slipper fuel tanks added to both wings.

Air Pace

surface weapon intended to increase the striking power and decrease the vulnerability of Bomber Command's fleet of V-bombers.

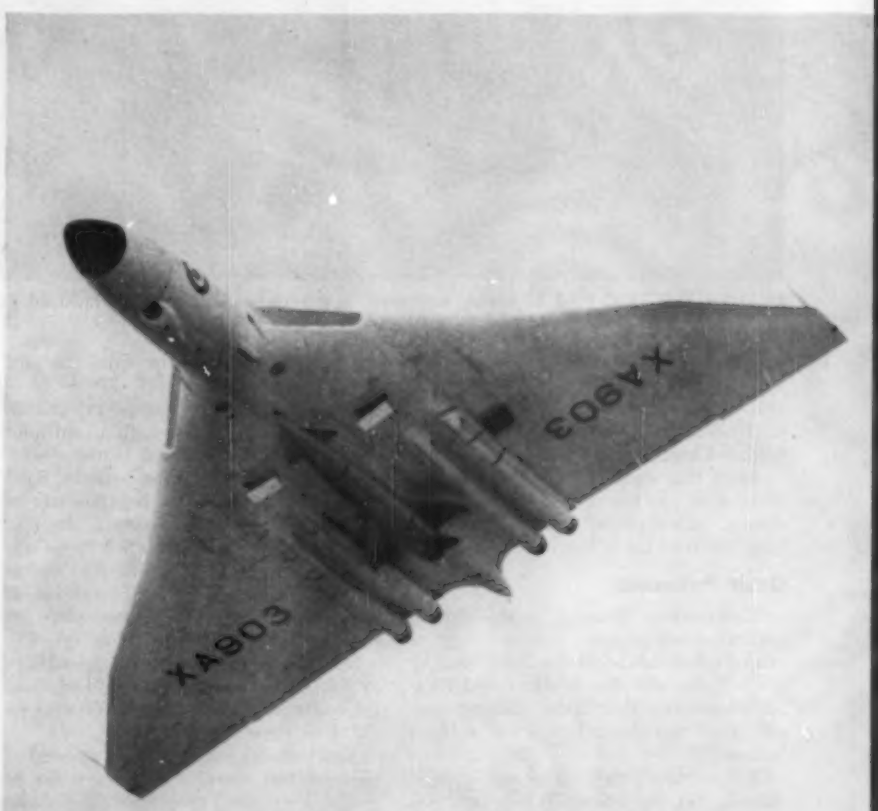
Shown in model form, as an aerodynamic test vehicle and as a mockup version flown under the belly of a white delta-winged Avro Vulcan, the standoff bomb—code-named Blue Steel in the now obsolete British system—resembles the Bell Aircraft Rascal now operational with USAF.

But Blue Steel has a larger range than the Bell missile—it has been launched at targets on the missile range at Woomera, Australia, from distances up to 400 mi.

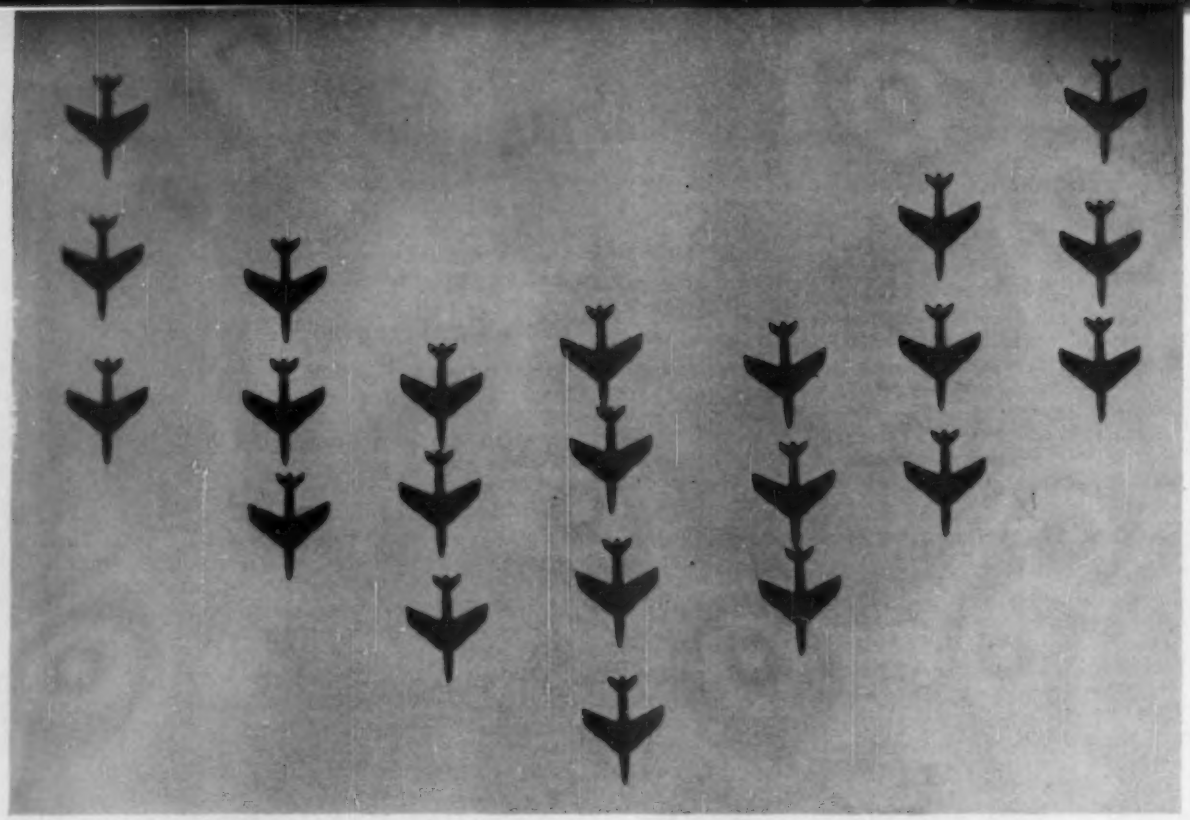
Estimates of the warhead have placed its strength at 20 megatons, but this value is considered high by visiting experts.

Blue Steel features a canard layout, with a cranked delta wing planform, vertical tail surfaces both above and below the fuselage and a horizontal tail at the forward end of the ogival body. It is carried externally in a partially submerged installation under the Vulcan bomb bay.

Saunders-Roe's Black Knight re-entry test vehicle and one of Britain's only hopes for experiments in the field of space technology was to have been shown at Farnborough if the first round

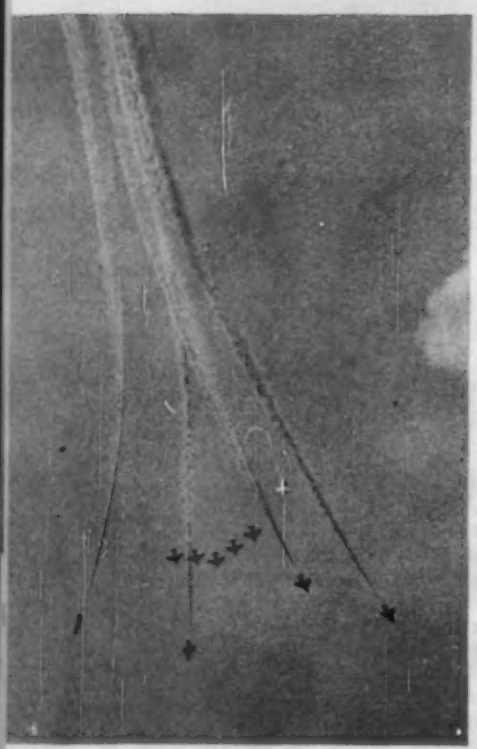


AVRO VULCAN B.1 delta wing bomber carrying air-to-ground rocket propelled missile with nuclear warhead. Missile has achieved supersonic speeds at altitudes up to 60,000 ft.



FORMATION of 22 Hawker Hunter Mark VI fighters of the 111 Squadron Royal Air Force as they began the first of two loops completed while holding this formation.

Farnborough Emphasizes Letup in British



SQUADRON continues its aerial strip tease in bomb burst maneuvers.

By David A. Anderton

Farnborough—There were no scientific surprises at this nineteenth Society of British Aircraft Constructors flying display and exhibition.

There were aircraft and missiles new in the sense that they had never been shown publicly before: a few missile and test vehicles, a couple of helicopters, the Fairey Rotodyne and the Blackburn NA.39 low-level naval attack fighter.

But by and large the show depended —as it always has done in large measure —on the superb piloting skills of such highly individualistic performers as English Electric's R. P. Beamont and Auster's Ranald Porteus. The crowd-pleasing and impressive flyby of service aircraft was enlarged even further this year. Between them, the Royal Air Force and the Royal Navy fielded 143 out of the 180 airplanes scheduled for the show.

This display also lacked the noticeably aggressive selling of British aircraft and associated products that has characterized past Farnboroughs. Instead the emphasis was placed on the amount of money now coming in as a result of earlier export sales. But this inward flow of money from Britain's worldwide aircraft markets threatens to dwindle to a trickle because of the lack of new types to sell.

There are no new Hunters, Canberras or Vampires that in the past have bulked large in the military export order books.

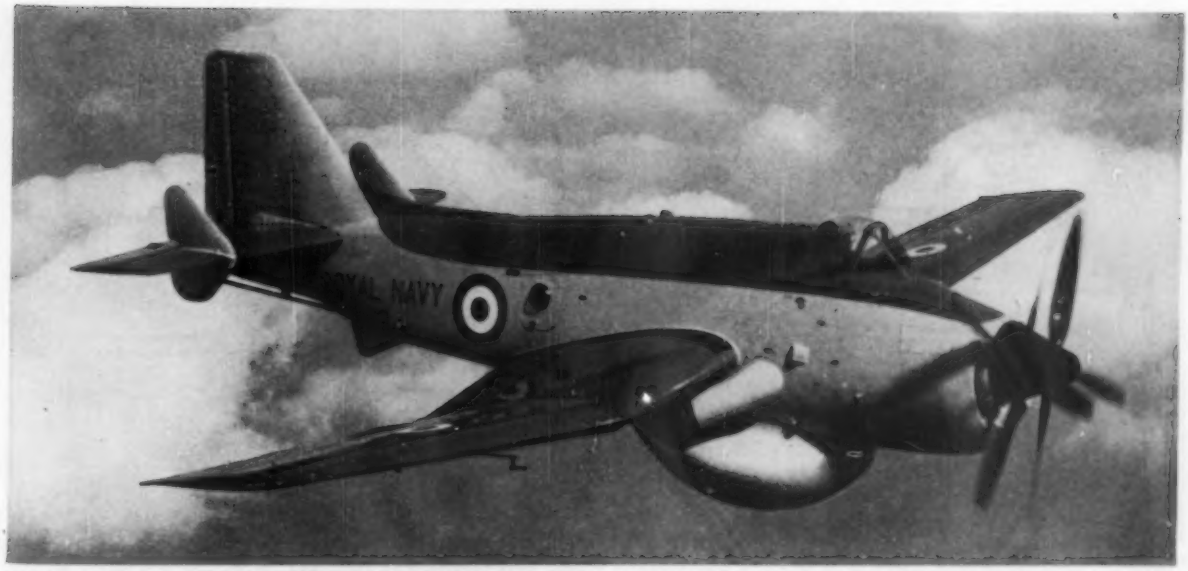
Vickers Viscount sales are beginning to taper off after the longest money-making run in the history of British aviation and the next generation of British transports—either turboprop or turbojet —has not yet prompted many buyers outside the Commonwealth to pick up their checkbooks and fountain pens.

There has been some hopeful talk about selling transports to Iron Curtain countries, but one visitor pointed out that it would be difficult to compete against Russian subsidized price levels in any transport category now known. For another viewpoint, see p. 47.

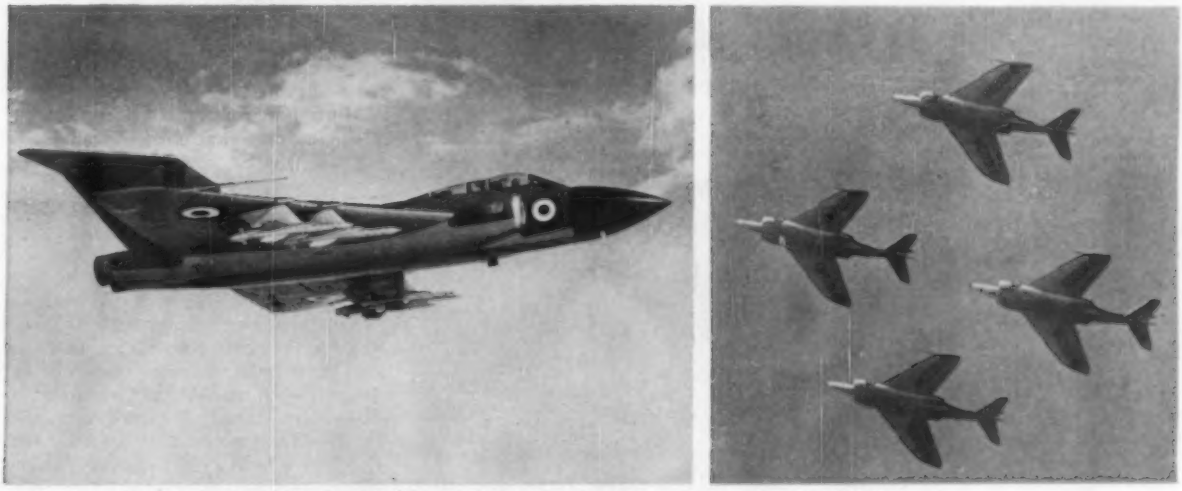
British missile systems, last year lauded as the coming financial savior of the industry, still are far from high-volume production and even farther from export sales.

Not one single sale for a British missile has been booked during the year since last Farnborough, a year that has seen almost every missile manufacturer outside of Britain sell products outside his native country.

Newest of the missiles was Avro's standoff bomb, a rocket-powered air-to-



FAIREY Aviation early warning version, re-designed from the original Gannet ASW aircraft, is now in service with the Royal Navy. Gannet Mk. 3 will replace the Douglas Skyraider in fleet service.



GLOSTER Javelin (left) carries de Havilland and Firestreak missiles. At right are Royal Navy Vickers Scimitars.

effective range of about 1,200 yd. Guidance is wire control and the missile is handled and launched in the usual manner. Features include a very short span, and a heading-demand control system. Flight control signals come from a unique gunstock type of double hand grip, with the marksman's right thumb fitted into a hollowed socket which is gimbal-mounted for motion in both the yaw and pitch planes about the natural axis of the thumb.

Vickers hopes to sell the weapon to the U. S. Army among others and has appointed Clevite Ordnance as sales agent for the firm in America.

Some rounds will be demonstrated to U. S. Army weapons teams by the end of this year, says Vickers.

The anti-tank missile for the British Army is under design and development at Fairey, and that company was allowed to announce only that single fact at Farnborough this year. Presumably the large-size Pye weapon—estimated to weigh about 200 lb. and using a ground-based computer system—was directly competitive with the Fairey design.

Pye's development uses visual guidance with optical aids and a thumb-operated joystick. Wire control systems are also used with this weapon, the wires being fed from bobbins at the wingtips.

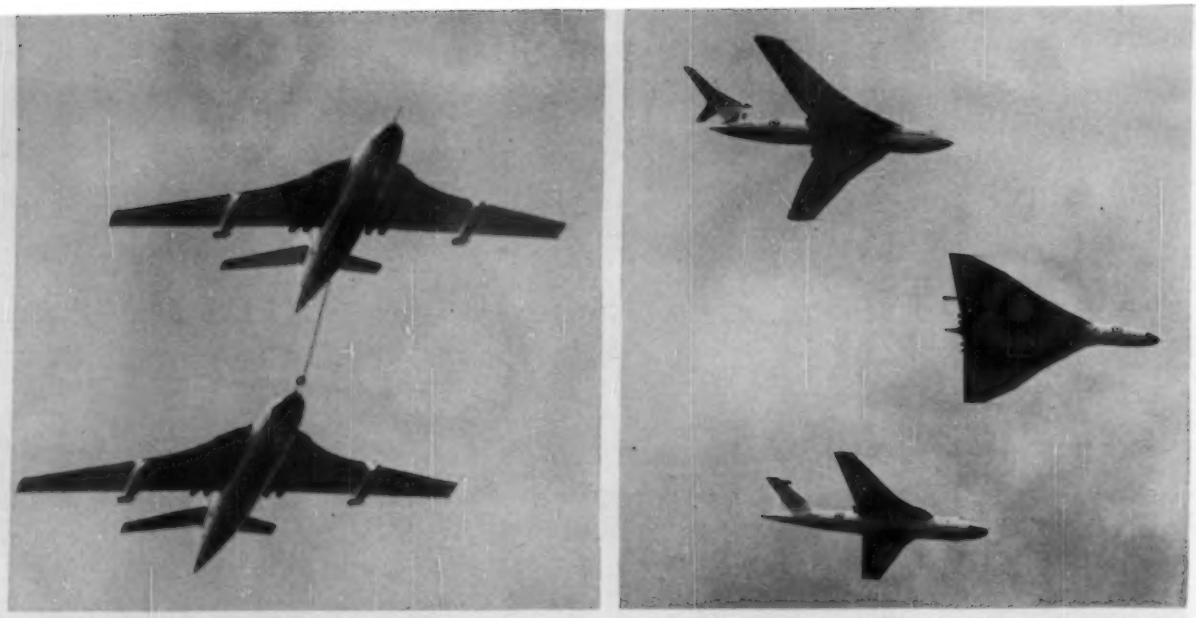
Pye technicians say the weapon compares in size and performance with the Australian Malkara weapon ordered by the British. Pye is prime contractor for the missile and its ground-based control system. The two-stage solid-fuel rocket motor was developed by Bristol Aircraft's Rocket Motor Division.

Most impressive of the helicopters in the display was the big Westland Westminster flying crane, a prototype weight lifter based on the Sikorsky S-56 rotor system and driven by a pair of Napier Eland gas turbines.

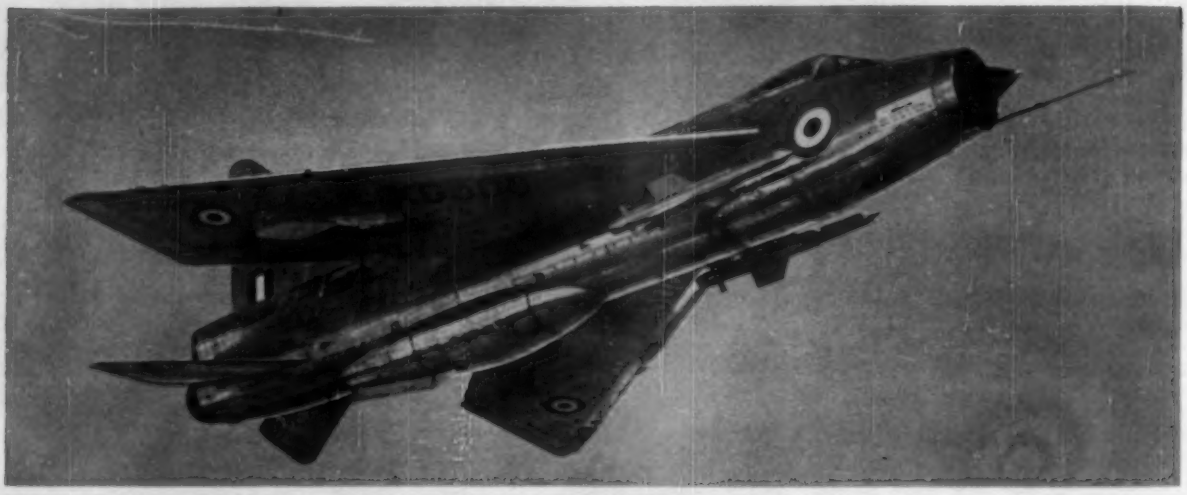
Fuselage of the Westminster is a simple tubular trusswork structure. Irreverent technicians have nicknamed the huge helicopter the Bridge over the River Kwai.

Private Venture

Westminster was built in eight months as a private venture by Westland Aircraft Ltd., holders of Sikorsky licenses in Britain. Like its other smaller sisters, the big helicopter derives much of its aerodynamic layout from the American designs, but relies on British powerplants. Lifting capacity of the flying crane is six tons, and passenger or troop capacity of a pro-



VICKERS VALIANT bombers (left) demonstrate aerial refueling using probe and drogue equipment. Royal Air Force trio of V bombers (right) is led by Avro Vulcan delta with the Handley Page Victor on its right wing (top) and the Vickers Valiant on left wing.



ENGLISH ELECTRIC P.1B Lightning supersonic fighter shown with two de Havilland Firestreak infrared homing air-to-air missiles.

had been fired successfully at Woomera. The firing was scheduled for Aug. 28 and the Black Knight itself was under tarpaulins and security guard across the field at Farnborough.

As of this writing, the firing had not been made and the vehicle had not been shown, although an ornate place had been reserved for it near the static tent.

Orbit Potential

Technicians familiar with British rocket development believe that a staged combination of the Black Knight test vehicle and the de Havilland Blue Streak intermediate range ballistic missile could put about half a ton payload in orbit.

Royal Navy's first ship-to-air guided missile, the Armstrong-Whitworth Sea Slug, was shown in test vehicle form on a display launcher. Neither launcher nor missile were in the final weapon form.

Sea Slug is a rocket-propelled missile of conventional layout, with a multiple-ramp launcher fed from below decks. Test firings of the various vehicles have been made at sea using components of the complete weapon system. In one recent test, a salvo of two Sea Slugs was fired at a drone target. The first round hit the drone, and the second round whipped through the largest piece of wreckage after the drone blew up.

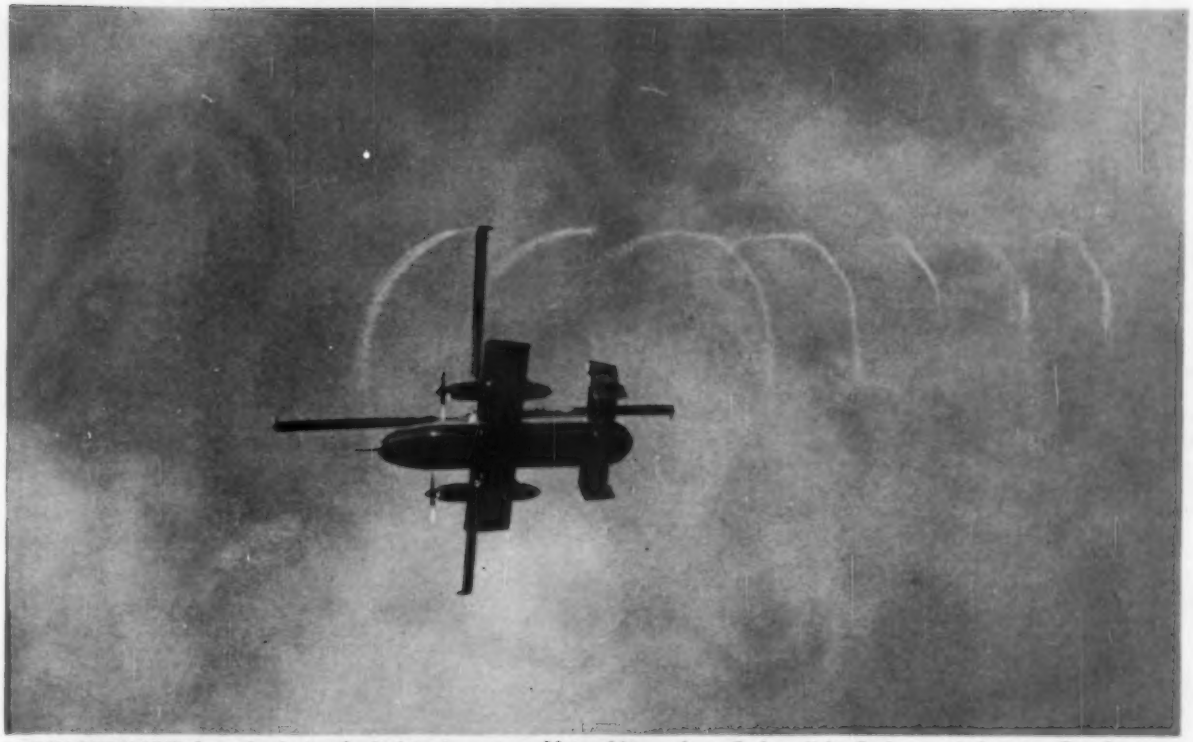
Sea Slug guidance is the responsibility of the General Electric Co. Ltd. and the control system is a Sperry Gyroscope Co. Ltd. development.

Short Bros. and Harland showed a recovery test round used in a series of tests to establish some of the basic parameters of active homing guidance systems. Developed from the old RTV-2 test vehicle, the recovery round is powered by a liquid-propellant rocket engine developed by the Royal Aircraft Establishment at Wescott, and uses kerosene and peroxide as propellants.

Two-stage parachute recovery system first deploys a cluster of three small parachutes, then releases a larger reefed chute which is gradually deployed as the vehicle slows down.

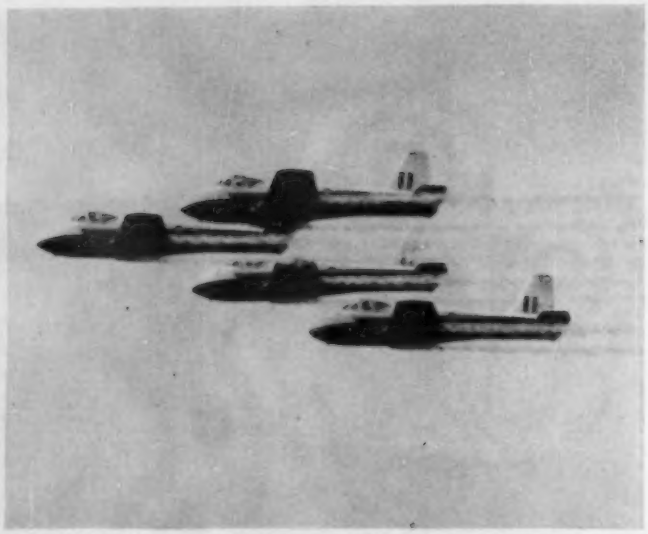
Flotation gear is used to aid the recovery of the round. Short Bros. is responsible for airframe, propulsion system and telemetry; Elliott Bros. (London) Ltd. has developed the active homing system.

Three anti-tank missiles are now under development in Britain and two of them—the Vickers 891 and the Pye missile—were shown. The Vickers unit is directly competitive with the French SS-10 and the Swiss Cobra with an



FAIREY ROTODYNE shown in air start for its jet rotor system. Note white smoke trails from lightoff of rotor tip burners. Rotodyne converts from main rotor during takeoff and landing to Napier Eland turboprops for cruising flight.

BRISTOL 192 helicopter powered by two Napier Gazelles gas turbine engines in flight. Aircraft has been ordered by the Royal Air Force and will carry 22 passengers or a 6,000 lb. freight payload.



FOLLAND GNAT lightweight fighter (left) shown in ground attack version with external fuel tanks and 16 rockets. Formation of four Percival Jet Provost trainers (right) flown by instructors from the RAF Central Flying School trail smoke during low level pass.

SAUNDERS ROE P.531 helicopter (above) is powered by Blackburn Turmo gas turbine engine. Below is Westland Westminster powered by twin Napier Eland 299 turbines.

posed transport version would be 46.

Westland's share of the flying display was also impressive. The firm fielded four helicopters in demonstrations of the flight characteristics of each.

Hottest performer was Roy Bradley, Westland's assistant chief test pilot, flying the Wessex, powered by a Napier Gazelle.

Bradley flung the British S-58 around in an amazing show of virtuosity and versatility. Climax was a series of sweeping passes that almost but not quite completely looped the Wessex.

The other new helicopter at the show was the Saunders Roe P.531, an entry in the popular five-place category of rotary wing aircraft. Powered by a Blackburn Turmo developed from the French Turbomeca gas turbine, the P. 531 was built by the company's helicopter division as a private venture. Detail design, construction and time to

P. 531's first flight took seven months.

Fairey Rotodyne, although classed as a rotary-wing aircraft, flew separately from the helicopter display to emphasize the fact that its performance potential combines some of the virtues of both helicopter and fixed wing planes. Ron Gellatly demonstrated highspeed runs of the Rotodyne in passes touching speeds of 170 kt.

But the preliminary type of noise suppressors fitted to the Rotodyne's fuel-burning tip pressure jets could not disguise the fact that it was one of the noisiest silenced aircraft ever heard at Farnborough. Liftoff of the Rotodyne was timed to coincide with a high-speed pass or an afterburner takeoff of the Fairey Delta, whose roaring Avon effectively masked the maximum noise level of the Rotodyne's chuffing rotors.

Gellatly also flew the Fairey Ultra Light helicopter, pound for pound the noisiest aircraft in the show.

He made takeoffs and landings from the back of a flatbody truck driven down the main runway at an estimated 15 mph.

Also featured in several demonstrations was the U.S.-developed LABS system of toss-bombing. Both the Avro Vulcan and the Handley Page Victor bombers heaved their huge bulks into the air in the rollout on top of a loop that is the characteristic maneuver of the LABS delivery. Seeing these big bombers flung around the sky like much smaller aircraft provided some of the most exciting moments of the flying display. A Vickers Scimitar flown during the Royal Navy demonstration made a scorching run for a simulated LABS approach. This plane, now in service with the Royal Navy, is the fastest British aircraft in squadron use. It is subsonic in level flight.

Herald Crashes

Farnborough—A Handley Page Herald, highly touted DC-3 replacement crashed and burned in a field near Farnborough Aug. 30. Pilot H. G. Hazelden and nine passengers escaped after a belly landing that ripped a hole in the fuselage side large enough for an emergency exit.

The Herald had been flying formation with a photographic plane when Hazelden suddenly declared an emergency and headed down.

One of the plane's Rolls-Royce Dart turboprops was afire and the fire was out of control. The engine eventually burned through the structure and fell out of the wing before landing. Part of the horizontal tail also burned away, making Hazelden's job somewhat tougher. Plane was essentially intact when it hit except for the missing engine and tailplane pieces.

Electric Motor Drives Kaman HTK-1

Electrically powered version of Kaman radio-controlled, pilotless helicopter has made its first flight at Bloomfield, Conn., plant of Kaman Aircraft Corp. Piston engine on Kaman HTK-1 trainer has been replaced with an electric motor which gets its power through a cable from a 250 kw. gas turbine-driven generator on the ground. System was developed under contract with Navy Bureau of Aeronautics. Major advantage, Kaman says, is long flight duration; electric power also provides inherent rotor speed governing. Evaluation tests are continuing at Bloomfield with a safety pilot aboard.

Finest precision flying by any acrobatic team was—as expected—done by Squadron Leader Roger Topp and 21 of his pilots flying the black Hawker Hunters of Squadron 111 (AW Jan. 13, p. 54).

They roared across the field and pulled up into a pair of formation loops, holding a V-formation of seven elements each with three planes in trail and with Topp riding the point of the V. After the loop, the aerial striptease began with the shedding of the outside six wingmen. The 16 formed a diamond and did an element roll with staggering precision—the entire group rolled as if rigidly fastened together.

Out of the roll, seven men peeled off to leave a nine-man unit for two more passes at the field in a diamond formation. Then they roared up into a loop and, after coming over the top, four pilots peeled away in a smoke trailing bombburst framing the remaining five-man element which then finished the show with more acrobatics and its own bombburst.

Navy Acrobatics

The acrobatic performance put up by the Royal Navy's 800 Squadron with Hawker-designed Sea Hawks and 803 Squadron with Scimitars was exceptionally good, but as one pilot said, "How can you compete with a sky full of Hunters?" On Sept. 1, officially a rehearsal day, there was some excitement when one of the Sea Hawk pilots got a firewarning light and peeled out of formation for an emergency landing at nearby Blackbushe Airport. He had to eject before reaching the field and the Sea Hawk slammed into the ground near some hangars at Blackbushe.

A3J-1 Makes Initial Flight

North American A3J-1 Vigilante, Mach 2 attack bomber developed for U. S. Navy, last week made its first flight at Columbus, Ohio. The twin-jet-powered aircraft was piloted on the 55 min. flight by R. M. Wenzell, chief engineering test pilot. Vigilante, which is capable of nuclear strikes, carries pilot and bombardier-navigator. Atomic stores are launched by firing them rearward from a tunnel-like bomb bay. System eliminates flow problems met by conventional launch methods at supersonic speeds (AW May 26, p. 30). The A3J-1 also can carry conventional bombs and missiles. Powerplants are two General Electric J79 engines of 15,000 lb. thrust each. Flight test program will be conducted at Palmdale, Calif.

New Hydrofoil May Bring Higher Speeds

Washington—Possibility of achieving a giant step in seaplane, submarine, underwater missile and surface ship performance has been opened for Navy by the development of a supercavitating hydrofoil section.

This supercavitating hydrofoil section which operates efficiently at translational speeds well over 150 kt. has raised Navy hopes for:

- **Supersonic seaplane** which lands on a small hydrofoil at around 200 kt.
- **Submarines and underwater** missiles with submerged speeds of well over 75 kt. and driven by propellers using the new hydrofoil section.
- **Surface ships cruising well** over 100 kt. and supported by certain small hydrofoils.

An important aspect of the new development is that the supercavitating hydrofoil is extremely quiet and, when used on propellers, is less noisy than the conventional screw used on today's surface and underwater vessels.

Theoretical work that produced this revolutionary hydrofoil section was performed by Marshall P. Tulin of the Office of Naval Research. Experimental proof of Tulin's ideas was presented at the second Symposium on Naval Hydrodynamics by H. Lerbs of the Hamburg Towing Tank Firm in Germany, and A. Tachmindji, of the Navy's David Taylor, Model Basin near Washington, D. C.

Edo Contract

Edo Float Co. and Grumman Aircraft Corp. are among the contractors working on hydrofoil design for the Navy and who presumably are putting the supercavitating principle to use.

Cavitation has in the past limited the efficiency of hydrodynamic propulsion devices such as conventional propellers, pumpjets and shrouded propellers and hydroskis and hydrofoils used to support surface craft traveling at high speeds.

Cavitation causes vibration, erosion and an increase in noise as well as a reduction in efficiency. It occurs when the pressure on the surface of a propeller or hydrofoil drops to the vapor pressure of the water through which it is passing.

The water then vaporizes or boils and a cavity of water vapor is formed on the surface of either the propeller or the foil.

Normally, the cavity of water vapor forms and collapses in a regular sequence and causes the corrosion and vibration and noise.

Tulin's mathematical treatment has enabled hydrodynamicists to prescribe the geometry for a supercavitating propeller or straight foil that is able to operate at high speeds while maintaining the cavitation bubble and keeping it from collapsing. The supercavitating section has a large blunt trailing edge which is equal to about 10% of its chord length.

Grumman Study

Supercavitating hydrofoil, if it can be successfully adapted for use on large craft in heavy seas, would give surface vessels speeds of well over 100 kt. in waves several feet high.

Grumman is working on a study contract for the Navy to determine the feasibility of 100 to 3,000-ton ships moving at those speeds for ranges up to and beyond 3,000 mi.

A 3,000-ton vessel of this type could revolutionize commercial sea travel by crossing the Atlantic in 24 hr. Grumman speculation about such a craft, if successful, indicates that its passenger accommodations probably would resemble those of a train. Space and weight would be saved since passengers would only have to be cared for for a single day.

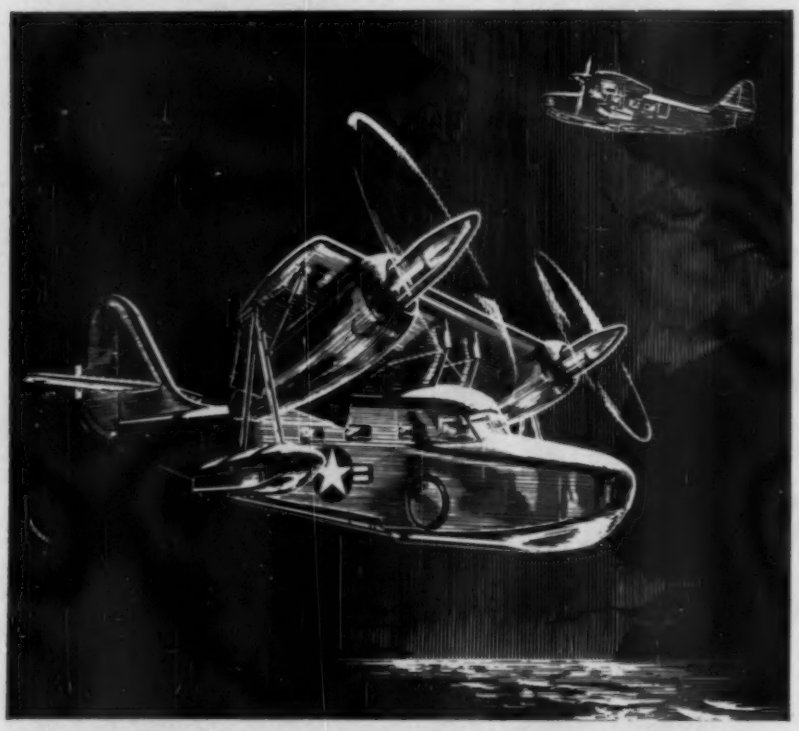
Anti-Sub Capacity

A surface vessel able to travel at more than 100 kt. also would change the anti-submarine warfare picture considerably by greatly increasing the effective operating area of destroyers, and other search ships.

The supercavitating propeller is considered to be desirable for other conventional surface ships which are now supported by a hull and generally restricted in speed by hull drag to about 40 kt.

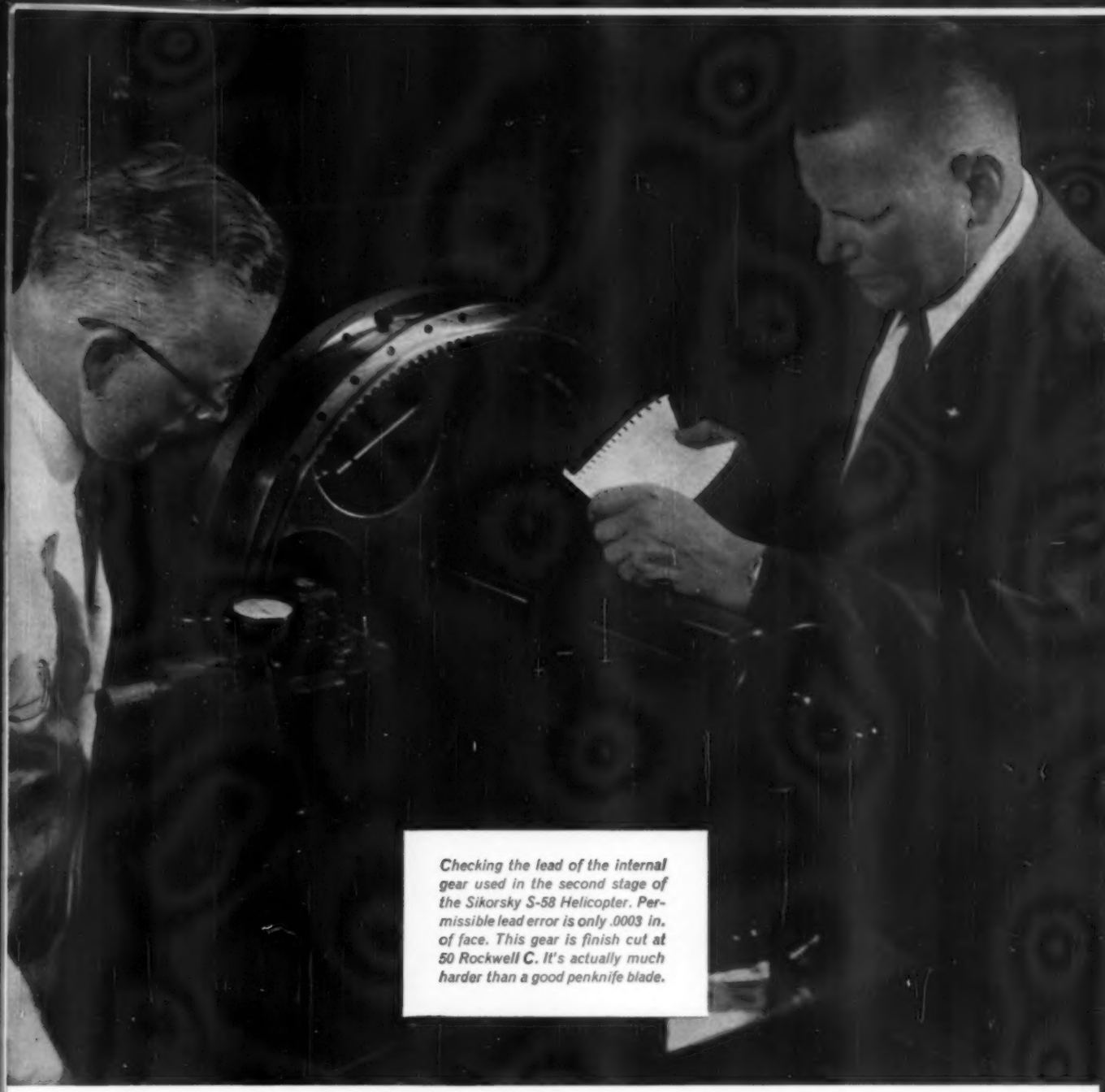
On these ships, heavy and costly reduction gear required between turbine powerplants and the normal slow-turning propeller could be largely eliminated.

The supercavitating propeller can operate efficiently at nearly the same revolutions per minute as the main turbine.



Kaman VTOL Utilizes Grumman Goose Fuselage

Kaman Aircraft Corp. will utilize Grumman Goose fuselage for its K-16B combination vertical and short takeoff and landing aircraft. Company is testing wing and propeller configuration at its Bloomfield, Conn., VTOL testbed (AW Mar. 31, p. 15). Concept is under development for U. S. Navy. K-16B will be powered by two General Electric T58 turbine engines, canted at 30 deg. Controllable flaps on propeller blades give pilot control at slow speeds (hovering to 50 mph.). Above 50 mph., flap control system automatically phases out and conventional airplane controls take over. K-16B will be used as flying test bed; two or three prototypes will be built.



Checking the lead of the internal gear used in the second stage of the Sikorsky S-58 Helicopter. Permissible lead error is only .0003 in. of face. This gear is finish cut at 50 Rockwell C. It's actually much harder than a good penknife blade.

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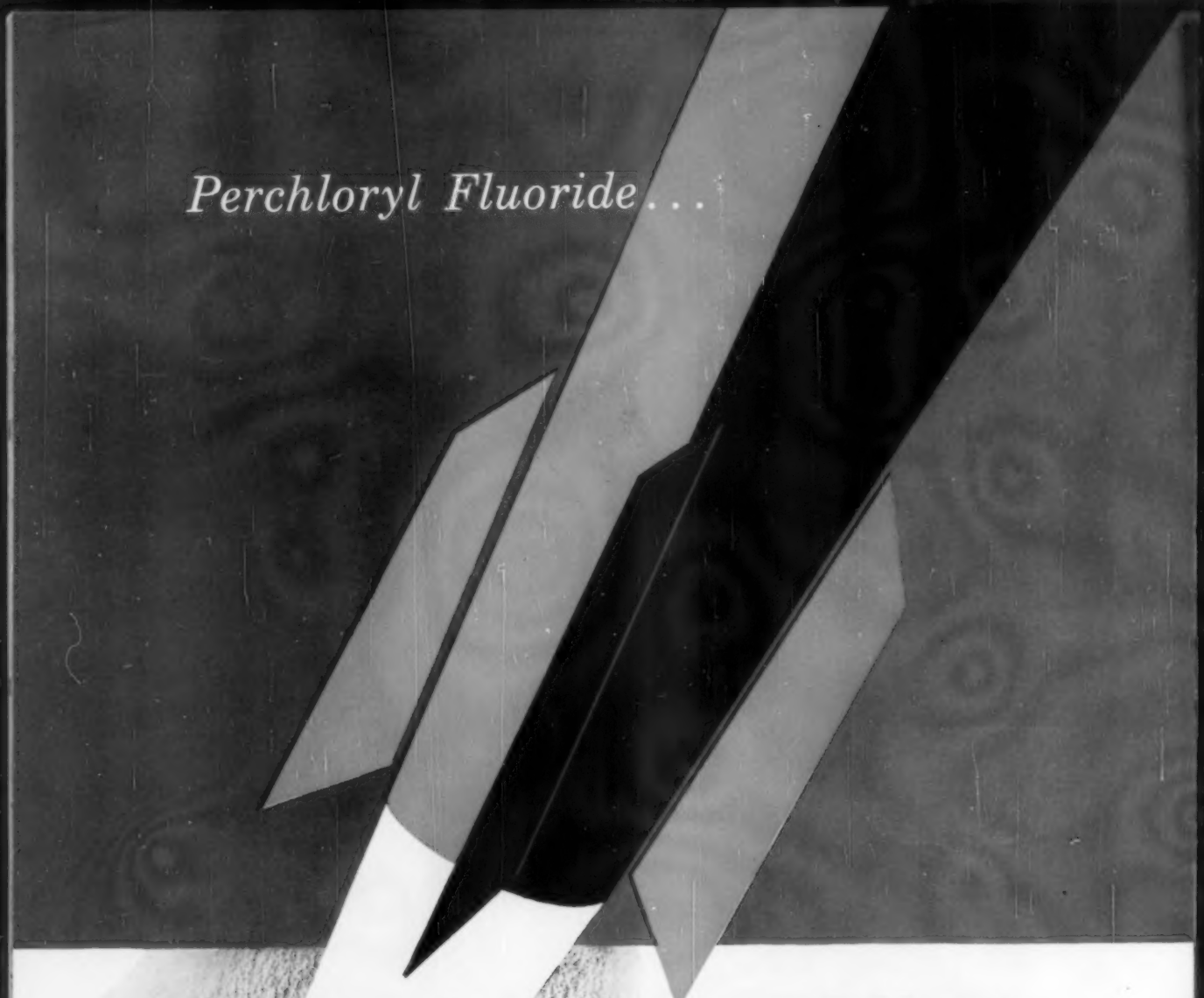

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Dyna-Soar Roles Outlined by Boeing

Washington—Working roles and responsibilities of major contractors associated with Boeing Aircraft Co. in Air Force's Dyna-Soar orbital bomber competition were outlined last week by Boeing Systems. They include:

- **Launching-base design development**—Aerojet-General Corp's Architectural and Engineering Division under the administration of Boeing's Pilotless Aircraft Division.
- **Pilot capsule and escape** mechanisms development—Chance Vought Aircraft Inc., administered by Boeing's Seattle Division.
- **Boost rocket systems development**—Aerojet-General's Boost Rocket Division, administered by Boeing's Seattle Division.
- **Tracking and telemetering** system management—General Electric Co.
- **Reconnaissance system management**—Ramo-Wooldridge Corp.
- **Automatic flight and landing** system management—North American Aviation Inc.'s Autonetics Division.
- **First-stage booster development**—North American Aviation Inc. Missile Development Division.
- **Radio guidance system** management—Goodyear Aircraft Corp.'s Avionics and Electronics Division.
- **High resolution radar** development—Radio Corp. of America.

The Boeing Systems group has received a competitive contract for first-phase development of Dyna-Soar. A competing contract for the Dyna-Soar program is held by a second group of companies with the Martin Co. as prime contractor.

Command Schedule Drafted by Defense

Washington—U. S. European Command will be established directly under the command of the Joint Chiefs of Staff and the Secretary of Defense on Sept. 15—the first of eight major operational commands to be placed directly under the JCS and the Secretary.

Recently enacted legislation reorganizing the Defense Department eliminated the secretaries of the military departments as executive agents administering operational commands.

Air Force Gen. Lauris Norstad commands the European command.

On Dec. 1, two commands will be placed under the Joint Chiefs of Staff, the Eastern Atlantic and Mediterranean Command, commanded by Adm. James L. Holloway, and the Alaska Command, commanded by USAF Lt. Gen. Frank A. Armstrong, Jr.

The five commands scheduled to make the change on Jan. 1 are the Caribbean Command, commanded by Army Lt. Gen. Ridgely Gaither; Atlantic Command, commanded by Adm. Jerauld Wright; Pacific Command, commanded by Adm. Harry D. Felt; Continental Air Defense Command, commanded by USAF Gen. Earle E. Partridge, and the Strategic Air Command, commanded by USAF Gen. Thomas Power.

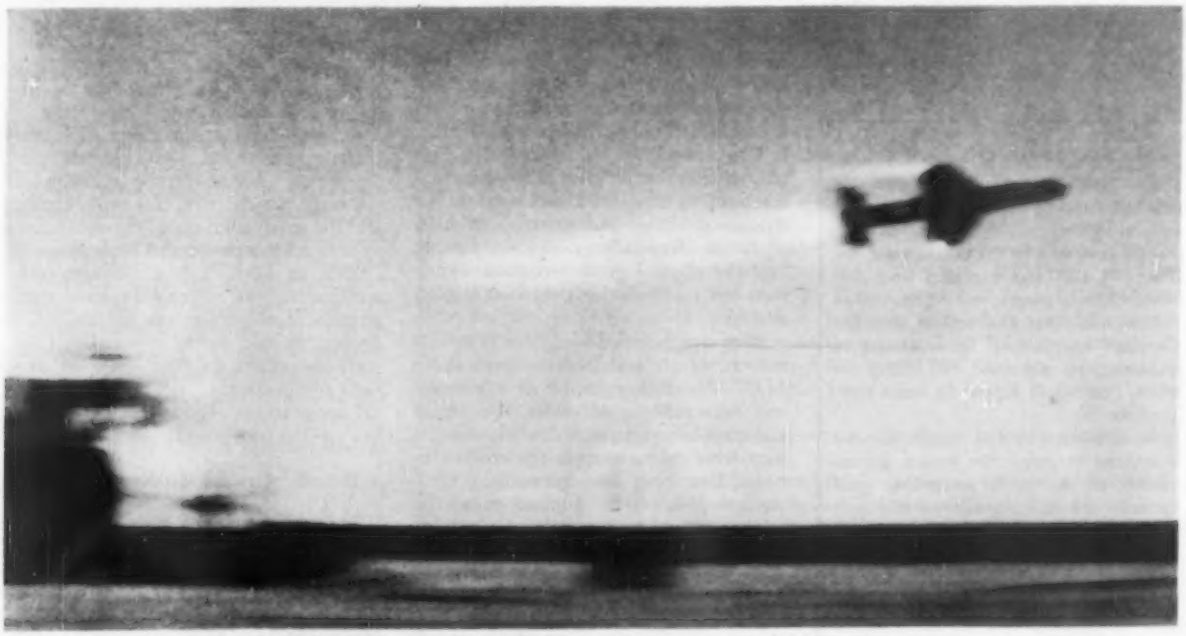
Expansion of the staff of the Joint Chiefs of Staff to assist JCS with its new responsibilities aimed at giving central direction to the defense establishment will be completed Jan. 1. The reorganization legislation increases the ceiling on the staff from 210 to 400. The JCS staff director is Air Force Lt. Gen. O. S. Picher.

The three services are reorganizing the functions of their assistant secretary posts. The reorganization legislation provides for the reduction in the number from four in each service to three. Only three of the posts are now filled in the Army. All four in Navy and Air Force are presently filled.

Bendix Wins Contract For Weather Data Unit

Ann Arbor, Mich.—Flying weather reconnaissance system that will enable four-engine Air Force jets to probe atmosphere on a gobal scale will be developed by Bendix Aviation's Systems Division under recently awarded contract.

The AN/AMQ-15 air weather reconnaissance system will include multiple radars for probing the inside of thunderstorms, rockets containing radiosondes that can be launched to make measurements at altitudes of up to 150,000 ft., parachute-borne radiosondes for probing lower altitudes plus electronic computers for analyzing vast



British Test Malkara Anti-Tank Missile

Australian anti-tank guided missile, Malkara, is fired on a 7,000 acre missile range on the Solway coast of Scotland. The 200 lb. ground-to-ground radio-controlled missile is launched from a mobile platform. Britain has ordered 160 Malkaras from Australia (AW Aug. 25, p. 47).

amount of data received. Weather data will be relayed to ground networks by radio.

Initial contract of what is expected to be a multi-million dollar program covers the first 12 months of a 36-month program of research, development and testing of a prototype system.

Boeing 707 prototype jetliner will be used to demonstrate system feasibility within the next 12 months. Boeing Airplane Co. is a principal associate of Bendix in the program. Six other company divisions also participating include Bendix Pacific Radio, Research Laboratories, Frieze Instrument, Eclipse-Pioneer and Bendix Computer.

Weather data obtained from the reconnaissance aircraft will be available to commercial airlines, U. S. Weather Bureau and other military services. System bears weapon system designation of 460L.

Space Training Team Checks Altitude Data

San Antonio—After 40 days of mountain experiments, researchers from the Air Force School of Aviation Medicine have drawn some tentative conclusions on the characteristics of future space travelers.

Dr. Bruno Balke, leader of the USAF research team, says the space traveler will be trained in pressure breathing and should be acclimatized to an altitude of about 14,000 ft. A man accustomed to the atmosphere of 14,000 ft. will be better protected against bends and lack of oxygen.

Man in space should be 30 to 45 years old, according to Dr. Balke; he will have to be at least 30 because it will take that long to get the required education and training. The spaceman will be in top physical condition, but not too muscular because muscles are relatively useless in the weightless state.

These conclusions are the early result of tests conducted by Dr. Balke, Dr. James A. Green and five volunteer USAF enlisted men during a 40 day stay on Mt. Evans in Colorado. Data from the tests are still being evaluated.

Team lived on Mt. Evans to gather information on the physical and mental reactions of men of various ages to the strains of living and working at high altitudes. Researchers also wanted to find the physiological endurance limits man can reach through exercise at high altitudes.

First studies involved the bends, a malady which usually hits fliers above 35,000 ft. if they aren't in a pressure suit or a pressurized cabin. The team had a mobile pressure chamber, and the men were taken to simulated high altitudes after they had become acclimatized to 10,000 ft. In two tests, the group suffered from the bends, indicating that acclimatization to 10,000 ft. doesn't offer enough protection.

After they had become acclimatized to 14,000 ft., the men exercised in the chamber for an hour at high simulated altitude with no bends. This test result confirmed early findings from tests made in Peru at 15,000 ft. that acclimatizing a man to 14,000 ft. on the ground gives him full protection from bends at higher altitudes, according to USAF researchers.

Italy Orders G.91

The Italian government has placed a firm order for 50 Fiat G.91s lightweight support fighter.

The company says a contract for another 50 G.91s is expected from the West German government by the end of this month. Fiat also reports that the Germans have shown keen interest in producing an additional 100 G.91s for which Fiat would supply the main components.

In addition, Fiat said negotiations for a contract to supply the French government with G.91s is proceeding satisfactorily and that negotiations to supply Switzerland, Austria and Argentina with G.91s are under way.

Design for the Fiat G.91 stemmed from North Atlantic Treaty Organization competition for a strike fighter capable of operating off unprepared strips and of being flown by pilots with low jet time (AW June 2, p. 54).

Satellite Failures

Washington—Details of the freak accident responsible for the failure of Army's Explorer V to go into orbit and the more routine mishap responsible for failure of Navy's first 20-in. Vanguard last May 27, have been disclosed following analysis of telemetered data.

Unexpected thrust generated in first-stage Explorer booster after burnout and separation by unconsumed gases and liquids caused it to collide with subsequent stages, knocking them off the required heading, according to Dr. Wernher von Braun. Special precautions are being taken to avoid recurrence of this type malfunction in future launchings, von Braun said.

Failure of the Vanguard second stage to cut off properly after reaching an altitude of 386 mi. caused the vehicle to fly with nose-up attitude instead of leveling off parallel to earth, the Navy reports. When the third stage was fired subsequently, it climbed to an altitude of 2,200 mi. instead of thrusting the vehicle into orbit. Had the satellite withstood reentry without burning up, it should have landed 7,500 mi. away near the coast of South Africa, according to calculations made by impact predictor.

News Digest

Ion propulsion for space flight will be explored by Marquardt Aircraft Co.'s Astro Division and Applied Radiation Corp. (Arco), of Walnut Creek, Calif. Companies also will study other forms of electrical propulsion on basis of a joint agreement reached last week. Astro Division also has under way several programs on propulsion systems for satellite boost and other hypersonic applications and is a major contractor on Project Pluto, Air Force-Atomic Energy Commission program on nuclear ramjet engine development.

Capt. J. A. Thomas, head of the weapon systems office of Bureau of Aeronautic's research and development group, has requested retirement effective Oct. 1. Associated with the bureau since August, 1955, Capt. Thomas probably will join private industry.

Lockheed Electra transport is scheduled for a series of demonstrations in Europe and the Middle East, beginning in October. Allison Division of General Motors, which designed and built the 501-D13 turboprop engine for the Electra, will share sponsorship of the tour, which is expected to last about six weeks.

Westinghouse Electric Corp. has uncovered a basically unexplored class of materials which can convert high-temperature source of heat directly into electricity. Thermo-electric materials are ceramics which, the company claims, are the first solid-state thermoelectric substances to operate at temperatures of 2,000F to 3,000F. Materials are technically described as "mixed valence compounds of the transition metals." Ceramics are said to be inherently stable and chemically inactive—even at very high temperatures, and promise practical applications requiring small quantities of electric power.

Braniff Airways failure to comply with Civil Aeronautics Board tariff filing rules resulted last week in rejection of the airline's proposal for a 15% surcharge on jet flights beginning Jan. 1, 1960. CAB's Bureau of Air Operations refused to accept the tariff notice and notified Braniff by letter that a major reason for its rejection was that the carrier failed to list the points between which the surcharge would apply.

Hope for Jet Noise Compromise Shaken

Favorable industry report, N. Y. Port Authority executive director's letter touch off controversy.

By Glenn Garrison

New York—Hope that the jet noise controversy here was working toward an amicable solution between the industry and the Port of New York Authority were shaken last week by developments which raised the possibility of a knock-down fight:

• **Angry reaction** to a letter from Austin Tobin, Port Authority executive director, written July 23 to European airport operators and disclosed publicly last week. The letter severely criticized the noise characteristics of the Boeing 707 jet transport and reported that airlines were resigned to possible severe operating restrictions. (See full text on following page.)

• **Favorable preliminary report** on the 707's suitability for Idlewild operation from a 7-man technical committee of National Air Transport Coordinating Committee, an industry group concerned with anti-noise measures in this area. (See text below.) Tobin is a member of NATCC's executive committee, to whom the report is addressed. Some observers saw this report as a countermove by the industry against the Port Authority's position.

Continuing conferences between the Port Authority and Pan American offered hope that a solution may still be reached. The airline's first 707-120 has been operating restricted trial flights at the airport, with a 190,000-lb. maximum takeoff weight being gradually raised to test community reaction.

Comet 4, 707 Compared

NATCC's technical committee reported that in one respect the 707 appears more acceptable than the de Havilland Comet 4, which recently underwent tests at the airport. That respect is the absence of rumble in the 707, a noise characteristic the committee said the Comet displays despite its suppressors.

Herbert O. Fisher, chief of the Port Authority's Aviation Development Division, is a member of the NATCC technical committee. However, Fisher did not concur in the report, according to the Port Authority, and has advised NATCC in writing to that effect. No Port Authority official, the agency says, has or will judge the 707's performance at Idlewild until tests there are final.

The letter to "my dear colleagues" includes references to statements made by Pan American, American Airlines and Boeing Airplane Co. These reactions were obtained by AVIATION WEEK:

• **American says it is** "impossible to reconcile" statements referred to in the letter with any statement made by an American official. The airline flatly denies that President C. R. Smith or Executive Vice President O. M. Mosier —or anyone else connected with American—told Tobin that the airline recognizes and accepts the fact that the 707 may not be able to operate from Idlewild except under severe limitations. The carrier also insists it did not agree to submit proposed operating restrictions and that it made no noise tests.

• **Pan American also denies** that any restrictions on regular commercial operations were proposed or accepted in principle.

• **Boeing says it was** and is perfectly happy with Pan American's request for the low-weight trial operation at Idlewild. On other issues discussed by Tobin in the letter, Boeing says it, and apparently most other manufacturers, airlines and airport operators are not in agreement with conclusions stated in the letter. Any statement on runway lengths, the manufacturer said, is premature, pending award of Civil Aeronautics Administration certificate, "and would only tend to further complicate the general subject."

Boeing said it was "unfortunate that the positive factors involved in the Boeing 707 and sound suppressor program were not more fully covered in the letter . . ."

The Tobin letter reports that after hearing the test 707 take off fully loaded during Seattle tests July 18, the Port Authority officials remained on the field to observe another 707 takeoff not scheduled as a test. This takeoff registered as noisier. The letter seems to suggest that caught off guard, Boeing

NATCC Committee Report

August 28, 1958

MEMORANDUM
TO: Executive Committee, NATCC
FROM: C. E. Rosendahl, Executive Director
SUBJECT: Report on Boeing 707 Noise Monitoring, Aug. 26, 1958

On Aug. 26, the NATCC Technical Committee and our public relations counsel had their first opportunity to hear the suppressor-equipped Boeing 707 on takeoff. The takeoff was conducted on Runway 13R at Idlewild. Our observation post was approximately 2½ mi. from the start of roll. This position, with the airplane load at 190,000 lb., is the equivalent of hearing it at 3½ mi. from the start of roll with a 247,000 lb. load. Weather at time of takeoff was: wind north at 9, temperature 69F, humidity 62%, ceiling 3,000 ft.,* visibility 6 mi. (* Estimated).

The consensus of our group was:

• The suppressors have virtually eliminated the rumbling noise which characterizes the unsuppressed jet.

• The climb potentialities of the airplane will be a major asset in noise abatement.

• The absence of the rumble, which tends to remain in an area for several minutes after the airplane has gone, appears to make this version of the 707 a more acceptable airplane noisewise than the Comet 4, according to NATCC observers who recently monitored Comet operations at Idlewild. The Comet 4, though suppressed, continues to create the rumbling noise.

• Because of its steep angle of climb, there was virtually no audible high frequency noise as the airplane approached.

• We feel there is a good possibility that after becoming accustomed to the difference between the Boeing noise and conventional aircraft noise, many people residing near the airport will prefer the jet noise for the reasons stated above.

We plan to make further observations to determine how increased weights and higher temperatures affect the climbout performance and the noise received on the ground as compared to yesterday.

The NATCC observers were C. E. Rosendahl, executive director; John Groves, ATA regional operations manager; J. D. Smith, ALPA regional safety chairman; Joseph Blatt, regional administrator of CAA; H. O. Fisher, Port of New York Authority; John F. Moynahan and Jack F. Ramsberger of NATCC public relations.

(Continued from preceding page)

or not such a procedure could be followed by Pan American. Furthermore, there is question as to whether or not the fully loaded Boeing under normal operating conditions would be able to "get off" the runway after a run of 7,500 ft., as Boeing's pilot did on Friday.

Boeing admits that the CAA tests of the fully loaded plane last month at Edwards Air Force Base in California indicated that a longer roll to takeoff would have to be anticipated. When we said that we had heard it said by the president of the Air Line Pilots Assn., that the 707 would need a takeoff run of 9,000 ft., the Boeing engineers did not deny this. And throughout the day they made many intimations that the desirable runway lengths which Boeing had heretofore suggested of 11,500 ft. might have to be therefore reconsidered.

They put this on the ground that many of the airlines are considering flights directly from New York to Rome or a similar distance which might require runways of as long as approximately 14,000 ft.

The demonstration plane made other fly-overs at heights varying from 620 to 1,500 ft. The flights at 1,100 ft. and over seemed tolerable, but the fly-over at the 600 ft. level was substantially noisier than the original takeoff, registering 106 over-all decibels (or, according to the Beranek formula, the equivalent of 121 decibels from a piston engine plane). The noise of these fly-overs was discounted by the Boeing representatives as not reflecting the takeoff procedures that they claimed had been demonstrated as practicable by the first flyover.

It so happened that another 707 was taking off immediately after these flights on one of the regular CAA testing flights. It was fully loaded. We elected to stay in the field and observe its passage. This was an actual taking off where the pilot was not concentrating on anti-noise procedures, and its decibel reading was about 106 (or, according to the Beranek formula, the equivalent of 121 decibels from a piston engine plane).

Throughout the day the Boeing engineers questioned Dr. Beranek on the validity of this subjective differential of 15 decibels between a hearer's response to a jet plane as compared with a piston engine plane. In our opinion, Dr. Beranek defended this theory and his figures very effectively, though he frankly admits that continuing and future experience might indicate that the differential is several decibels lower than his present estimate of 15.

The Boeing people are very unhappy about the conditions which Pan American proposed for the trial flights of the 707. They obviously feel that by proposing such limitations Pan American indicated their acceptance of the fact that there were very serious noise problems involved in the possibilities of operating the fully loaded 707 from New York International Airport. All, however, agreed that the Pan American proposal and our acceptance of it opened the door for progressive tests and experience in the field which will demonstrate the takeoff weights (and so the altitudes over the surrounding communities) at which it will be possible to operate.

Austin J. Tobin
Executive Director

could not make as favorable a showing.

Boeing's comment on this point is that certain climb profiles were requested for the test and adhered to, and were not comparable to other flights where no noise considerations were involved. Airlines will set up their own takeoff profiles, Boeing said, and the fact that the demonstrations showed the feasibility of the test profile would indicate it would be suitable for scheduled operations.

The Port Authority's noise consultants, Bolt Beranek and Newman, are not monitoring the Idlewild flights.

Unofficially, some industry spokesmen are criticizing the Tobin letter in stronger terms and wondering why it was written. The Port Authority, however, refuses to discuss the letter in any of its aspects.

One possible reason for the Tobin letter, suggested by an industry source, was that the Port Authority was in pretty much of a lonely corner and sought what support it could muster. Whether attributable to the letter or not, it is a fact that since its transmittal both London and Paris have taken precautions against jet operations at their airports. London set tentative operating restrictions against all jets but the Comet 4 and Caravelle, and Pan American – along with Russia's Aeroflot–must use Le Bourget instead of Orly Airport at Paris until a runway extension over less populated areas is completed at Orly (AW Aug. 18, p. 43).

Summary of events leading up to the present situation might be outlined as follows, including some elements of speculation:

• **Port Authority's** reaffirmation of its original 1951 ban of all jets not satisfying its noise level requirements served notice to manufacturers that they must make efforts to suppress jet aircraft noise. Some credit certainly must go to the agency for the fact that suppressors were deigned and installed.

• **Boeing 707s noise level** with suppressors definitely displeased the agency after its tests early this year in Seattle. But the Port Authority refused to commit itself, and still will not publicly evaluate its noise test data. Some industry sources believe Boeing failed to realize the threat and added fuel to the fire by lack of cooperation. Boeing denies this and points to the large sums it has spent on supressors and noise flight tests.

• **Pressure on the Port Authority** to clarify its stand mounted as time grew shorter, with first scheduled operations from Idlewild planned Nov. 1. The factor of national jet age leadership was injected into the situation when Harold Watkinson, British Minister of Transport and Civil Aviation, told New York reporters that Tobin had discussed the 707s noise with him and that he foresaw serious problems with the plane at London. British Overseas Airways Corp., Watkinson then said, would begin translatlantic jet service "at least as soon" as Pan American (AW July 21, p. 30).

• **Pan American** and the Port Authority worked out the plan to bring the 707-120 into Idlewild for trial operation under agreed-upon restrictions with the aim of easing the jets into New York and offering everyone a pleasant way out. At this time, there was some industry speculation that high-level U. S. government interest in the national prestige factor may have been a consideration in the Port Authority-Pan American agreement.

• **Tobin wrote** the "My Dear Colleague" letter, possibly to seek support of his position in case the trial did not satisfy the Port Authority.

• **707-120** came into Idlewild last month and began its tests (AW Sept. 1, p. 28). Then the Tobin letter broke into the open, and recriminations began to fly.

Airport Aid Program Vetoed by President

Washington–Expansion of the Federal Aid to Airports Program was blocked last week by a presidential veto of the bill that would have extended the program another five years and increased it from $63 million to $100 million a year.

The current program is scheduled to end at the close of the Fiscal Year, June 30, 1959. To meet commitments already made, approximately $60 million to $70 million will be needed in addition to funds that have been authorized but are unexpended.

Text of Port Authority's 'My Dear Colleague' Letter

(The following letter, dated July 23, was sent to Western European airport operators by Austin J. Tobin, executive director of the Port of New York Authority. Because it gives the first specific, detailed insight into the Port Authority's thinking for the record on the Boeing 707 noise issue, AVIATION WEEK *is publishing it in full.)*

My Dear Colleague:

John Wiley and I had long meetings on July 15, first with American Airlines and then with Pan American World Airways, to review and discuss the grim airport problems brought about by the excessive external noise of the Boeing 707 and the failure of their noise-suppressor program to bring the fully loaded 707 down to tolerable levels of neighborhood noise. Mr. C. R. Smith, president, and Mr. O. M. Mosier, executive vice president, represented American Airlines, and Mr. Harold Gray, executive vice president, was the Pan American representative.

The most important aspect of the discussions was that, for all practical purposes, these two airlines, which will be the first ones to accept deliveries of the 707, now both recognize and accept the fact that there is serious doubt as to whether or not the fully loaded 707s (coast-to-coast for American or transatlantic for Pan American) can operate from New York International except under very severe operating limitations. For instance, Mr. Gray volunteered that, although such a thing would have seemed incredible to him a few months ago, he now knew that he must contemplate the real possibility of light takeoffs on the transatlantic run from New York International, with a stop at Boston to take on the full load of fuel required for the transatlantic crossing. Mr. Mosier, for American, told us they have been making their own calculations of the neighborhood noise that would be caused by the 707 at its maximum takeoff weight of 247,000 lb. required for the coast-to-coast flight. American's calculations of over-all decibel readings (103) are remarkably close to those suggested to us by Dr. Beranek, our acoustical consultant, who calculates that the noise factor over Inwood, almost four miles from the start of takeoff, would be the equivalent of a noise of almost 120 decibels made by a plane with the present piston-type engines. Both airlines agreed to formulate and submit for further discussion the operating limitations at the airport that they themselves thought they would have to impose on their full-weight takeoffs, such, for instance, as weight limitations, confining the flights to runways that avoid the nearest neighboring communities, avoidance of flights during the night hours and the like.

While these conversations were going on, Boeing telephoned from Seattle to say that they were finally ready to permit us to make the noise measurements and recordings of the fully loaded 707 and that these fly-overs would be held in Seattle early Friday morning, July 18. We immediately arranged to have our acoustical engineering consultants get out to Seattle with their equipment. C. R. Smith, Harold Gray, and we, ourselves, all decided also that we should be present to hear these fly-overs with the fully loaded plane in the field, that is, at some point in Seattle about three and a half miles from the start of takeoff, which would simulate the position of the communities closest to New York International.

During the course of our discussions with Harold Gray on Wednesday, he submitted a draft of a letter from Pan American requesting permission to run a series of trial flights out of New York International, commencing about Aug. 15, with a very lightly loaded Boeing, not to exceed 190,000 lb. He suggested that Pan American would be willing to limit these trial flights back and forth to Puerto Rico to takeoffs and landings during daylight hours. Since such a lightly loaded plane could quickly attain an altitude of 1,500 ft. or more over the communities, at which height it would cause no real noise nuisance, we felt that the permission should be granted. Furthermore, it seemed wise to us to grant the permission immediately for if it were granted after the Boeing tests of July 18, it would be hard to dissociate the permission from a conclusion in the public mind that in the opinion of the Port Authority and the airline the fully loaded 707 could be operated in and out of New York International Airport at noise levels that would be tolerable to the surrounding communities. Since this is not the fact, an association in the minds of the public of the completion of the tests of the heavily loaded 707 on July 18, with permission given within a few days thereafter for the operation of the 707, would be confusing and unfortunate.

On July 15 we worked with Mr. Gray on an exchange of letters in which Pan American requested the permission subject to the following conditions:

(A) Gross weight of the 707 to be used on these trial runs would not exceed 190,000 lb.

(B) Aircraft will attain an altitude of 1,500 ft. or more before it reaches the communities adjacent to the airport.

(C) Takeoffs and landings would be made only between the hours of 8 a.m. and 6 p.m.

(D) Takeoffs would be confined to four runways, south over Jamaica Bay (two runways), east over Inwood, and west over Howard Beach.

The Port Authority's consent could be revoked or revised at any time.

In John Wiley's letter granting the permission on these conditions, he noted that earlier this year, Bolt Beranek and Newman had made sound measurements of partially loaded Boeing 707 aircraft, and he said: "On the basis of these measurements they (Bolt Beranek and Newman) advise us that the noise of the aircraft you propose to operate on these trial runs, as it will be heard in the communities adjoining the airport, should be quite tolerable and should not exceed, indeed, it may be very much less than, the noise of many long distance aircraft now in service out of New York International Airport."

We spent all day Friday, July 18, at Seattle with the Boeing people and the officers of Pan American and American Airlines, at the flyovers of the heavily loaded (247,000 lb.) 707, and in conference and discussions thereafter at the Boeing plant on our observations and the over-all problem of community noise and the 707. At three and a half miles from the start-of-roll the Boeing passed overhead at about 850 ft., the pilot having made a wet takeoff, and then cut his power back from maximum takeoff power to normal climb power just before reaching the three and a half mile point. The over-all decibel reading was 102. Using Bolt Beranek and Newman's factor of subjective equivalence to the sound of a piston engine plane, the noise on the ground would be equivalent to a piston engine plane with a decibel reading of about 117 decibels.

This procedure, as executed by Boeing's test pilot, was a deliberate and acknowledged effort to get the heavily loaded plane at the highest altitude possible over the three and a half mile point and then by a reduction in power (at, say, the three mile point) to minimize community noise.

There is a question in my mind whether the airlines or their regular commercial pilots will be willing to follow such a procedure. In Seattle on July 18, Harold Gray, executive vice president of Pan American, said that until he had much more data and was able to study the problem further on the basis of their familiarization flights he would be unable to say whether

(Continued on following page)

Domestic Lines Battle Qantas Route Bid

By L. L. Doty

Washington—Bid by Qantas Empire Airways of Australia for a cut in U. S. travel markets (AW May 19, p. 38) is developing into another test case as to just how generous the U. S. can afford to be in negotiating international bilateral air pacts.

Although the Qantas case presumably will be decided by the Civil Aeronautics Board entirely on its legal merits, a decision favorable to Qantas could inject one more loophole into bilateral agreements that would, in the words of one airline official, open wider the floodgates of foreign competition on U. S. domestic routes.

A decision against Qantas could substantially strengthen the stand of U. S. trunklines against any further invasions of domestic markets by foreign flag carriers. As in the case of the French bilateral agreement (AW Aug. 11, p. 31), domestic carriers are showing stronger resistance to the granting of traffic rights to foreign airlines than are some U. S. airlines with international routes.

Qantas is seeking an interpretation of the Air Commerce Act of 1926 that would give it the right to carry international passengers, either inbound or outbound from the U. S., between San Francisco and New York in either direction.

The Qantas request has drawn strong opposition in the form of statements and arguments from United Air Lines, American Airlines and the Air Transport Assn. Qantas, Japan Air Lines and British Overseas Airways Corp. filed documents in support of the petition asking for an interpretation of present laws that international passengers are excluded from the provisions of "cabotage."

Actually, at stake is the issue of cabotage which reserves the right of a country to confine the transportation of passengers, freight and mail to its national airlines within that country's boundaries. Qantas wants to know if cabotage, which some attorneys compare to a "closed door" restriction, doesn't pertain to domestic passengers only.

Although TWA and Pan American did not sign the ATA statement—it was officially endorsed by 11 trunklines, one local service airline and one Alaskan carrier—most observers do not construe this to imply a split within the industry on the issue.

In the past, there have been numerous splits on bilaterals with other countries, the type and scope of the differences depending on the issues at stake. Many observers blame this lack of cohesion within the industry as one of the reasons the State Department has not taken a firmer stand in previous negotiations with foreign countries.

However, it is generally conceded within the industry that both Pan American and TWA support the position against the Qantas move but preferred to withhold public endorsement of the opposition rather than risk strained relations with those countries they serve. TWA, in particular, would find little to gain in most countries in which it operates from a reciprocal exchange of traffic rights under the interpretation of cabotage principles sought by Qantas.

Main fear of the domestic trunklines is the strong possibility of a heavy diversion of traffic from domestic carriers to foreign carriers as more traffic rights are granted to the latter by widening the scope of bilateral pacts. Already, the operation of polar routes by foreign airlines has drawn bitter protests from domestic airlines on grounds that such operations drain a significant volume of traffic from U. S. routes.

Precedent Feared

In the Qantas case, the trunklines are worried that a decision supporting the Qantas petition would set a precedent that would be hard to elude in the interpretation of bilaterals with other countries. They point to the demands of Italy, in current negotiations, calling for traffic rights within the U. S. at least comparable to those granted to Germany and the Netherlands, as two examples.

In its statements, the ATA said there are now 27 route segments within the U. S. and its territories on which foreign governments have operating rights. The association added that international traffic moving on domestic carriers over these routes is estimated at $25 million for the calendar year 1957.

On its behalf, Qantas claims that the loss of traffic it will sustain on the San Francisco-New York portion of its Australia-England route to the American carriers will far exceed any traffic it obtains from an interchange with other international carriers. The airline points out that its two flights weekly will be competing with more than "150 flights offered in each direction by American, United and TWA."

Qantas says its prime objective is to carry traffic from Australia to England, not only because of British-Commonwealth ties, but because of the economic factor inherent in such a long haul. For the same economic reasons—longer haul and greater yield per seat mile—it places its second objective on traffic between U. S. or Canada and Australia. Third objective, the airline states, is Fifth Freedom traffic across the Atlantic to and from the U. S.

Qantas' original petition asked for an interpretive ruling on the cabotage principles in the Air Commerce Act of 1926. Although this act was repealed by the Federal Aviation Act of 1958, the section in question was lifted from the Air Commerce Act and incorporated in the new act.

United Air Lines asked to intervene and American petitioned to dismiss the Qantas request. Qantas immediately asked the Board to undertake public rule-making procedures and reiterated its stand that "the only relief requested was a strictly legal interpretation of the meaning of the cabotage restriction set forth" in the Air Commerce Act.

On June 20 the Board served notice to all scheduled airlines holding either a certificate of convenience and necessity or a foreign air carrier permit that rule-making procedures would be adopted and that American's and United's motions were denied.

Deadline for all comments from interested parties was set for Aug. 7 but was pushed back to Aug. 28 by the Board on the request of several carriers. The Board, in its draft release, broadened the scope of the issue and called for more than an interpretation of the Air Commerce Act in order to reach a decision.

In this connection, Qantas requested in its statement filed Aug. 28 that the Board issue "an interpretive regulation to the effect that a foreign air carrier, holding a foreign air carrier permit, is authorized, while conducting operations in accordance therewith, to carry international trans-shipment traffic between the U. S. points specified therein, unless the permit specifically or by necessary implication withholds such rights."

Russia Rejects Japanese Air Link

Tokyo—Japanese Foreign Office last week announced Japanese bid to fly Moscow-Tokyo exchange route had been rejected by Russia because "no international route had been mapped for it."

Earlier this year, Russia had proposed negotiations to establish an air link between Tokyo and the Siberian port city of Khabarovsk. The latest Russian reply suggested, however, that Japanese airliners might use the established international routes from Copenhagen or Berlin to Moscow.

Another good reason gourmets say:

The BEST WAY is by TWA

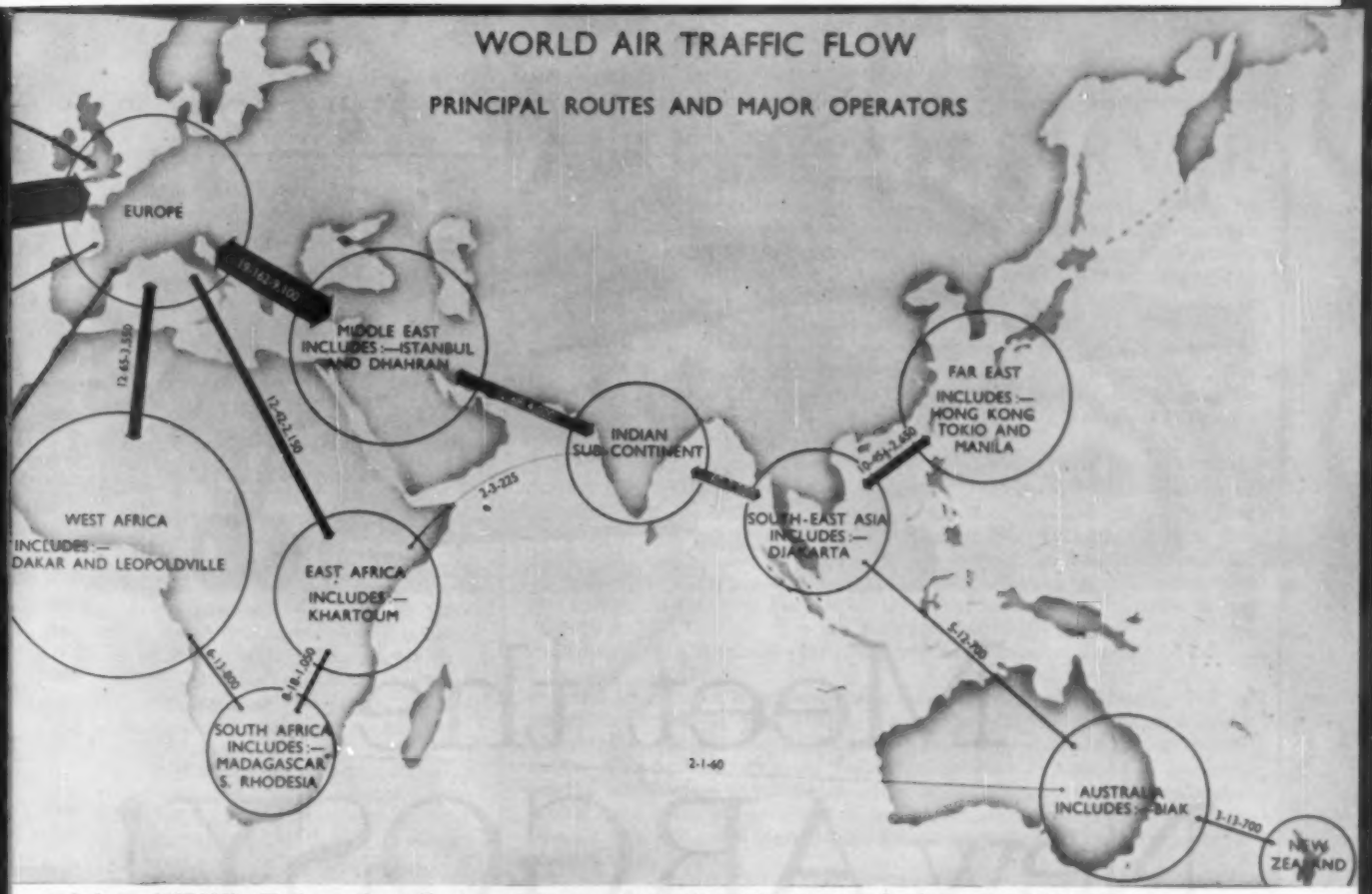
EXCLUSIVE

Dave Chasen, noted Beverly Hills restaurateur, approves a great entree.

Sirloin of beef... broiled to your order in flight!

Your Ambassador flight hums toward the evening sun. Dinner is served—a celebrated event on TWA. You begin with cocktails, you conclude with coffee, a choice of liqueurs, and a satisfied sigh. But the high point, an airline innovation by TWA chefs and Dave Chasen, is a culinary masterwork—a tender cut of prime sirloin of beef broiled in flight to individual taste. All this, of course, part of a most pleasant and rewarding trip by TWA Ambassador.

FLY THE FINEST... FLY **TWA** TRANS WORLD AIRLINES



week during 1957-1958. Thickness of a traffic stream is in proportion to the number of seats offered on a particular route.

$227,000 for the cost of moving its headquarters from Ithaca to Utica, N. Y., was termed a "basic area of difficulty" by the CAB which recognized only the amount of $21,311 spent for this purpose through April, 1958.

Reviewing a general salary increase for chief executive officers of the carriers from a low of $12,000 a year in 1950 to the present allowable maximum of $20,000, the CAB noted the long term upward trend of prices and wages and voted to increase the salary ceiling to $25,000, pointing out that the new wage level will apply to all local service carriers.

Determination of the final rate for Mohawk was based on the airline's break-even need of $1,604,736 plus a return of $469,970 on an investment base of $4,947,057. The total amounts to 43.38 cents per revenue mile, excluding an estimated $56,992 in service mail pay.

Britannia Sales Down, Bristol Plans Layoff

London—Because the supply of Bristol Britannia aircraft has outstripped demand, Bristol Aircraft Co. plans to lay off another 600 workers by the end of 1958. About 1,200 employes already have been laid off so far this year.

Despite "fairly encouraging" Britannia sales recently, some aircraft are being made ahead of orders and the company aims to cut back expenditure until these aircraft are sold.

To stave off further redundancies, Bristol is pulling in work subcontracted.

Of the 37 Britannias under construction or completed at the company's plant, seven—worth about $25 million—are unsold.

Oxygen Requirements Tightened by CAB

Washington—A Civil Aeronautics Board regulation calling for increased oxygen protection of passengers and crew became effective last week.

Under the new ruling, one pilot crew member will be required to wear an oxygen mask at all times when flight operations are above altitudes of 25,000 ft. All other crew members will be required to have masks on their person.

Purpose of the revised regulation is to prevent any risk of crew black-out in the event of rapid decompression. Oxygen and oxygen dispensing equipment must be available for all passengers on aircraft operating above 25,000 ft.

The rule also requires crew members to brief passengers on the use of the equipment prior to entering the established altitude boundary.

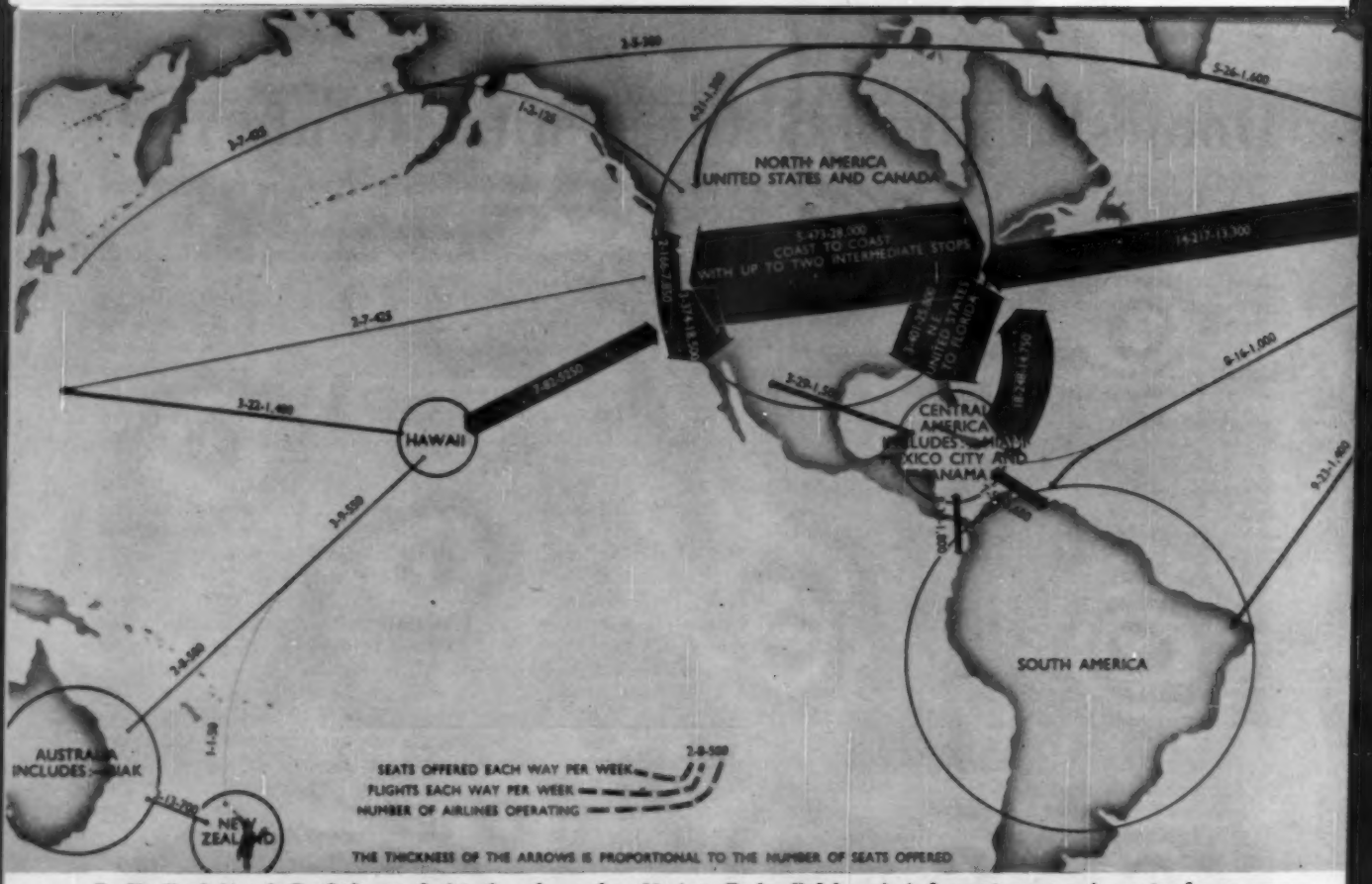
Base cruising altitude at which oxygen must be provided was raised from 8,000 ft. to 10,000 ft.

CAA, Air Force Plan Joint Use of Radar Data

Washington—Civil Aeronautics Administration and Air Force Air Defense Command last week announced a program for the joint use of civil and military radar in air traffic control.

Under the program, worked out by a permanent Joint Radar Planning Group, 31 new long-range radar facilities will be put into air traffic control use by the CAA while still serving for air defense activities by the Air Force, Army and National Guard.

Microwave links and air traffic control radar displays are being purchased and installed for use of radar data from Air Defense Command facilities at air route traffic control centers which are located in the following cities: Kansas City, Spokane, New York, San Antonio, Great Falls, Mont., Jacksonville, Oakland, Los Angeles, Washington, New Orleans, Fort Worth, Memphis and Seattle.



De Havilland Aircraft Co. Ltd. map depicts the volume of world air traffic handled by principal operators on major routes for an average

Controversial Rate of Return Plan Applied to Mohawk's Mail Rates

Washington—Civil Aeronautics Board indicated last week that it will apply its controversial 9.5% rate of return plan to final mail rates tentatively approved for Mohawk Airlines (AW May 12 p. 40). The rate of return plan is based upon a "Cost of Capital" approach offered earlier by the Bureau of Air Operations in the Local Service Carrier Rate of Return Investigation.

At the same time, the Board spelled out its willingness to help underwrite the cost of re-equipment programs for the local service industry as a major part of its conclusions in the Mohawk mail rate case.

Raising the rate from its present 8% to 9.5% will provide the airline with a total annual mail subsidy of $2,015,014, the Board said.

Noting that Mohawk has not contested the proposed rate, although it earlier requested a higher rate in the Rate of Return Investigation, the CAB said it will apply the 9.5% return to all local service carriers receiving future final mail rates pending a decision in the rate of return case. A majority of local service carriers having a low investment base, as compared with the 90% debt-equity ratio of Mohawk, oppose the cost of capital theory and want a minimum return of 12%.

Pointing out the inability of local service carriers to attain self sufficiency with an all DC-3 fleet, CAB approved Mohawk's addition of 11 Convair 240s to the former eight DC-3 fleet as a "step in the right direction."

Adding that, while such fleet expansions could be expected to increase subsidies, the Board repeated its belief that the public is entitled to better local service transportation with faster and more modern aircraft "providing that such service can be obtained at a reasonable subsidy cost." The Board also observed that subsidy assistance to Mohawk at this time is in keeping with CAB policy to aid the development of the local service industry by such means as improved route structures and guaranteed loan legislation.

Major consideration behind its decision to underwrite Mohawk's mixed fleet operation arose from the carrier's gradual introduction of Convairs over its most densely traveled routes while retaining its DC-3s for schedules that will not support the larger aircraft.

The Board, however, declined to recognize for rate making purposes, the airline's full Convair fleet on the grounds that Mohawk's scheduled mileage forecast calling for 16,6[illegible] Convair hours would produce a utilization rate of only 3.9 hours per day. Use of only nine Convairs, the Board said, should enable the airline to realize all of the mileage forecast and result in an acceptable utilization rate of 4.9 hours a day.

Analysis of the carrier's recent growth trend, in view of general business conditions, indicates that Mohawk's system passenger-miles will increase approximately 5.4% over the level recorded for last year, said the CAB. For rate making purposes the Board added that it expects the carrier to realize a system load factor of 51.57%, resulting in more than 83 million passenger-miles this year.

Under operating expenses, the Board recognized annual depreciation expenses of $480,619 for the nine Convairs and provided for obsolescence of DC-3 expendable spare profits totaling $25,000 to be amortized over a five-and-one-half year period from July 1, 1955.

Mohawk's claim for amortization of

SHORTLINES

▶ **Chicago Helicopter Airways** reports that it carried more than 10,000 passengers during the first 26 days of August to become the first helicopter carrier to go over the 10,000 mark for a single month.

▶ **Civil Aeronautics Administration** has invited bids for grading, drainage and related work on Washington International Airport at Chantilly, Va. Job will call for the movement of about 8,500,000 cu. yd. of earth, installation of 11 mi. of drainage pipe and 158 catch basins and inlets into drain systems.

▶ **Mohawk Airlines** carried its two millionth passenger on Aug. 26. Mohawk President Robert E. Peach pointed out that one million passengers flew with Mohawk in the first 11 yr. of operation, whereas the second million were carried in the space of 28 mo.

▶ **Northwest Airlines** reports a company record for passenger revenues, operating revenues, gross and net incomes for the month of July. Passenger revenues for the period were $7,928,178, up 20.4%; operating revenues were up 22.7% at $9,722,373. Total operating income before taxes, interest, expense and property disposals was $1,948,316, up 69%; net income for the month was up 82% at $795,383, as compared with July, 1957.

▶ **Seaboard & Western Airlines'** transatlantic air freight traffic in July totaled 1,683,000 ton miles flown, an 86% increase over the same period in 1957.

▶ **Thai Airways Co. (TAC),** national airline of Thailand, was scheduled to suspend its bi-weekly service between Tokyo and Hong Kong via Taipei effective Sept. 1. The airline also was scheduled to stop its Bangkok-Singapore service on the same date. TAC will continue to operate scheduled service between Hong Kong and Bangkok via Taipei, and between Bangkok, Rangoon and Calcutta. TAC inaugurated its Tokyo, Hong Kong, Taipei and Bangkok service in May, 1951. Since February the airline's three Lockheed 1049G Constellations used over the route have been grounded.

▶ **Trans-Canada Air Lines** carried a total of 344,035 passengers on its border flights during the first seven months of 1958. Traffic on the airline's routes between New York to Montreal and Toronto and Cleveland and Chicago to Toronto has shown an 8% increase over the same period last year.

AIRLINE OBSERVER

▶ **Watch for a penetration of the airline market behind the Iron Curtain by a western manufacturer which will trigger a tense competitive battle between the Soviet Union and the democracies for the sale to international airlines of turbine-powered equipment. The Polish airline, LOT, is showing strong interest in the Vickers turboprop Viscount, and Vickers-Armstrongs officials are convinced that negotiations with the state-owned airline have been successful. Russia, which has been campaigning hard to peddle its impressive array of turbojets and turboprops outside Russia, already has been rebuffed by the United Arab Republic in an aircraft sales effort and can be expected to intensify its propaganda campaign if the Vickers sale materializes.**

▶ Scheduled airlines experienced a decided improvement in passenger traffic during the past three weeks and are now beginning to show increased optimism over prospects for improved revenues for the year. Another bright spot in the over-all industry picture has been encouraging signs that bank and insurance company resistance to increases in long-term loans for re-equipment program may be easing slightly. Demand for airline common stock listed on the New York Stock Exchange remained fairly stable during August despite the fact that net earnings may drop to their lowest level in eight years as the result of a constantly rising expense level.

▶ **American Airlines is pushing back inaugural date of its Boeing 707 jet transport service so that Boeing can undertake all modification work requested by the airline. In the past, American has carried out all modification of its new aircraft at its Tulsa overhaul base as a means of accelerating the introduction of scheduled service for new equipment. An estimated 40,000 man-hours are involved in the modifications called for by the airline. Transcontinental service with the turbojets is now expected to begin some time in January.**

▶ Self-contained exit and emergency markers for aircraft interiors requiring no electrical connections or other external power sources will be offered by the United States Radium Corp. Units consist of glass tubes internally coated with a special phosphor and filled with tritium gas. Light is emitted when phosphor coating is excited by the tritium gas. Markers will provide uninterrupted light for periods up to 25 yr. and are visible at a distance of 100 ft.

▶ **Russia's Aeroflot state-owned airline is planning to introduce another version of its Tu-104 turbojet transport "in the near future." Present version carries 70 passengers. The new model is designed "to increase seat-mile economy by better utilization of fuselage space" and will accommodate 100 passengers, carry a payload of 26,400 lb. Known as the Tu-104B, the plane's general appearance is the same as the original model although the fuselage has been lengthened by 47 in.**

▶ United Air Lines has taken delivery on its last piston-engine aircraft, a DC-6A cargoliner, to bring the carrier's total fleet to 198 piston-engine planes. Conversion to a turbojet fleet will begin next year with delivery of the first of 40 Douglas DC-8s followed by the first of 11 Boeing 720s in 1960. Retirement of the carrier's fleet of DC-7s will begin in 1961.

▶ **Production program of East Germany's civil jet transport, the Baade BB-152 (AW July 28, p. 33), calls for delivery of the first series-produced model to East Germany's airline, Deutsche Lufthansa, in December, 1959. Two prototypes of the model have been completed. Third prototype will serve for propulsion unit testing. Fourth model is scheduled for completion in May, 1959, the fifth in September, 1959. The sixth, which will be used for fatigue testing, also is scheduled for completion in September, 1959.**

▶ American Airlines has awarded contracts to nine leading oil firms which could result in the purchase of as much as four billion gallons of kerosene during the next 10 yr. The airline estimated that its fleet of 110 turbine-powered aircraft will consume about 450 million gallons of jet fuel annually. Approximately 60% of the total fuel requirement will be provided by Esso Standard Oil (N. J.) and Shell Oil Co.

Meet the New ARGOSY!

THE WORLD'S FIRST TURBOPROP FREIGHTERCOACH TAKES ON A GREAT NAME IN CIVIL AVIATION

In the story of British aeronautical achievement, some great names stand out: aircraft that made their mark in the skies and helped to further aviation progress.

Such a name is the ARGOSY—the first civil aircraft built by Sir W. G. Armstrong Whitworth Aircraft Ltd., back in 1926. It made history as the first commercial aircraft to pay its way for an airline, and inaugurated Imperial Airways' famous Silver Wing lunch-time service between London and Paris. Economic operations were made possible by its trouble-free maintenance, reliability and carrying capacity.

The new turboprop ARGOSY, to make its first flight by the end of the year, is the jet-age successor of its famous namesake. And like the old ARGOSY, the Freightercoach (designated the AW650) will open a new era in air transportation. It is a most versatile aircraft. Not only can it carry up to 80 passengers in pressurised comfort at a speed of 300 miles an hour, it will also open a vast new market in air freight.

The modern ARGOSY carries over three times the load of a Dakota at twice the speed and half the cost.

PERFORMANCE

POWER: 4 Rolls-Royce Darts
AIRCRAFT CRUISING SPEED: (14,000 r.p.m.) 296 m.p.h.
MAXIMUM PAYLOAD: 27,000 lb.
RANGE WITH 20,000 lb. PAYLOAD: 1,600 st.m.
SIZE OF HOLD: 46 ft. 8 in. (14.23 m.) x 10 ft. (3.05 m.); floor area 426 sq. ft. (39.6 sq. m.).

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The *Argosy* — BRINGS THE COST OF AIR FREIGHT DOWN TO EARTH

"FIRST FAMILY" of the jet world now includes four axial-flow jet engines, all pictured here. At left, the famous J-57; with afterburner it develops over 15,000 pounds-thrust. The commerical version (without afterburner) is the JT3. At far right is the big J-75 with afterburner, which produces over 20,000 pounds-thrust. Commerical version (without afterburner) is the JT4. Bottom center is the 7500 pound-thrust J-52. Behind it is the new JT12, appearing almost tiny beside its powerful big brothers.

rugged, efficient engine that reflects Pratt & Whitney's extensive engine-building experience. The JT12 weighs only 430 pounds, yet due to its advanced design it produces 2900 pounds of dry static thrust. With a single spool and fixed geometry, the JT12 promises outstanding performance, reliability and ease of maintenance for many possible applications.

Meanwhile at Pratt & Whitney Aircraft's research and development centers in Connecticut and Florida development continues on the powerful new J-58 engine, and various aircraft propulsion systems of the future are being explored or developed. When the time comes, they will be ready to take their places as working members of the world's "first family" of power plants for flight.

Pratt & Whitney Aircraft *Division of United Aircraft Corporation*

CONNECTICUT OPERATIONS—East Hartford, Meriden, Middletown, North Haven, Southington
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"FIRST FAMILY" OF THE JET WORLD...

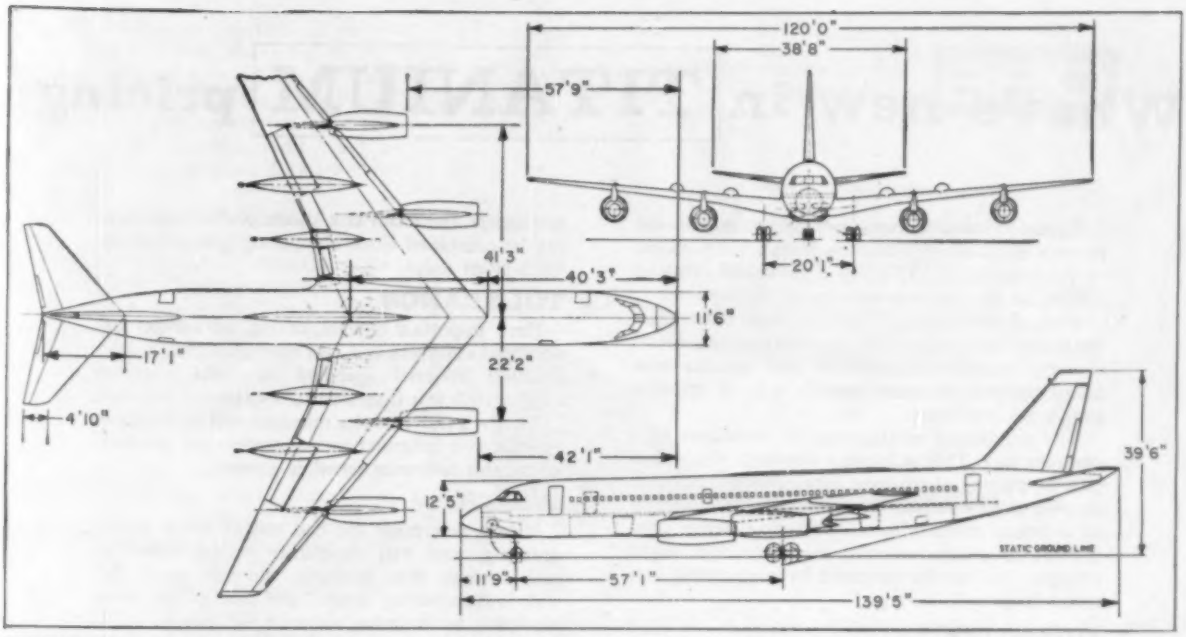
From engines of tremendous power to a smaller new one of 2900 pounds thrust, the world's "first family" of jet power plants bears the name of Pratt & Whitney Aircraft.

No other group of jet engines has achieved comparable prominence . . . won on the basis of design superiority, manufacturing excellence, and uniformly top-notch performance and dependability. And no other group of jet engines has even approached the contributions made by this axial-flow family to American superiority in jet aviation—military and commercial.

Most powerful members of the family now in production are the twin-spool J-75 and J-57 engines. They have accumulated nearly 3 million hours in many assignments . . . in bombers, tanker-transports, fighters and attack aircraft. Their commercial versions, the JT4 and JT3, will power the majority of jet transports ordered by U. S. and foreign airlines.

The smaller twin-spool J-52 is in the medium power range. This 7500 pound-thrust engine is slated to power a new missile, and a new twin-engined attack fighter.

Smallest and newest is the JT12, a simply-built,



CONVAIR 600 swept wing, 7 deg. dihedral is illustrated in this three-view schematic. Wing sweep is 35 deg.

to Meet Jet Age Problems

of full Fowler flaps on the outboard section yielded too high pitch moments, so a compromise was reached by giving this section about half the travel and position of a full Fowler installation.

Improvement in trailing edge yielded higher angles of attack, resulting in separation, so leading edge devices were explored, with testing accomplished on a dropped leading edge, slats and all kinds of leading edge flaps, with the final configuration being a leading edge slot which is hydraulically actuated.

Aerodynamic Seal

Slots substantially improved lift coefficient at high angles of attack, and with hydraulic actuation being used, dovetailing extrusions were designed which provide an aerodynamic seal when the slot is retracted.

The slots run from wingtip to inboard pylon and extend the wing chord 3% at the leading edge along their span. They are tailored to the 600, and include certain local adjustments that are required for best aerodynamic characteristics.

Chord changes increased the wing from the 2,000 sq. ft. area of the 880 to 2,250 sq. ft. for the 600. However, Convair sought to retain the wing torsion box as intact as possible (with an eye to tooling and end product costs), and by making changes in the leading and trailing edge wound up with a thinner wing than is used on the 880. Wing sweep remained 35 deg. and dihedral stayed at 7 deg.

Since the basic 880 airfoil profiles had been changed by leading and trailing edge developments, additional aerodynamic work was done and reflex (a slight dishing inward of the top surface near the trailing area) was introduced in the 600 outboard wing area, along with a slight warp, to get the minimum drag associated with optimum spanwise load distribution, and to minimize drag due to trim (compared with a normal wing) in this area.

Having gained speed with aft fan engines and a thinner wing with reflex, the drag rise problem naturally was emphasized.

Convair aerodynamicists had been aware of Richard Whitcomb's area rule developments (AW July 14, p. 49) and worked closely with National Advisory Committee for Aeronautics to develop the anti-shock bodies; and although the original company concept had been based on a different pupose for wing top surface bodies, thinking merged to develop the four pods now used.

Much wind tunnel research and development went into the present configuration, which is completely tailored to this installation. Tunnel work ran the gamut from one to nine bodies per wing, varying locations and dimensions, with two finally selected as the best compromise.

With the antishock bodies minimiz-

MACH .91 cruise condition produces shock wave over basic wing (top). Shock-destroying effect of bodies is shown at bottom.

LARGE wind tunnel model of Convair 600 jet transport shows wing antishock bodies which employ the area rule concept.

Area Rule Concept Fits Convair's 600

By Richard Sweeney

San Diego—Convair has taken advantage of recent technical developments to ensure that its Model 600 jet transport will not face speed obsolescence, a factor which most often dictates replacement of major portions of airline fleets.

For example, Convair, a division of General Dynamics Corp., has designed the Model 600 to fly a full 20-year first line life before fatigue becomes a maintenance problem.

The 600 incorporates wing antishock bodies which employ the area rule concept to increase cruise and critical Mach numbers (AW July 14, p. 49), has four General Electric CJ-805-21 aft fan turbojet engines which obtain 35-40% more dry static thrust at takeoff and up to 8% more thrust at altitude than current engines without any increase in fuel consumption.

American Airlines has ordered 25 of the 600 transports, (AW Aug. 4, p. 38), and plans to take advantage of the plane's speed to operate a "Blue Streak" transcontinental nonstop run which should be 45 min. faster than the competition.

Serious development of the 600 started after specifications for the Convair 880 jet transport were made final in February, 1956. The program was basically one of research and improvement of the basic 880 design (AW April 10, 1956, p. 99), which was then designated Model 22 or Skylark 600, the latter designation being dropped soon after the airplane was announced.

Development, at a relatively low level of effort, sought improvement in three basic areas:

- **Improvement in high speed** capabilities.
- **Reduction in direct** operating costs at best speed.
- **Improved landing** and takeoff performance.

Streamline Effect

During this period, bodies similar to the anti-shock bodies of the current 600 design were being considered, but in connection with main landing gear housing. Good streamlining effect was anticipated, based on aerodynamic research performed in Germany some time prior.

In 1957, American Airlines came up with a set of specifications which resulted in an increased development effort which culminated in the 600.

Frank W. Kolk, director of equipment research for American, pressed for improvements in landing and takeoff which would enable the 600 to operate from La Guardia Field, N. Y. He would use La Guardia as a terminal for the transcontinental nonstop run, then have the airplane turn around and originate flights to Chicago or of a similar distance, on an economical basis and without any modification or change in the basic airplane.

First American requirement was the addition of three-seat rows, meaning higher weights, and it was at this time that intensive aerodynamic work was accomplished on flaps and leading edge devices to meet the increased weight.

Determining that the airplane was not limited as to Civil Aeronautics Administration field length or climb gradient, aerodynamicists computed that the wing aspect ratio could be lowered by an increase in chord at the leading trailing edge or both. They had learned that the best high speed characteristics were obtained here by extending the trailing edge.

First move was an across-the-board trailing edge extension of 16 in., which later was changed to a 25-in. extension from tip to wing center section, where the extension was gradually reduced to that point where the trailing edge intersects with the wing-fuselage fairing.

Major arrangement of the trailing edge aerodynamic surfaces of the basic 880 wing were retained; i.e., inboard and outboard flaps were used, with aileron between, and inboard and outboard spoilers retained. However, all surfaces were redesigned due to trailing edge changes and incorporation of antishock bodies.

Larger flaps were incorporated on the 600, and the inboard flap was made a full Fowler-type (double slotted). Use

What's new in TITANIUM pricing:

Recent price reductions in titanium metal—the seventh initiated by Titanium Metals Corporation of America since 1954—have provoked renewed interest in the design properties of the material.

With prices down 45 percent from levels four years ago, and weight, heat, and corrosion problems severely increased in aircraft and missiles now being devised, titanium metal's role is growing ever more important.

The purchasing of titanium can sometimes be a complex task. TMCA hopes it can help you in that task by passing along some reminders on methods to save money on the "price extras" that apply to all orders of titanium metal. Of course, design considerations are paramount, but sometimes slight changes that can be tolerated by engineering can mean large cash savings.

✶ QUANTITY

Production costs decrease as the amount of material being processed increases. Therefore, quantity schedules have been established to pass along economies to the purchaser. A customer can often benefit by careful consideration of the amount of material he is ordering, compared to the quantity schedule as outlined in TMCA's Buyer's Guide. In many cases, because of applicable quantity extras, upwards of 1,000 pounds of titanium metal are available at no charge to the purchaser. For example, a 10,000 pound shipment of heat-treatable forging billet can cost exactly the same as a 9,074 pound order; a 5,000 pound shipment of plate can cost exactly the amount of a 4,802 pound order. TMCA's district sales managers are always willing to help you take advantage of the price breaks.

✶ PATTERN SIZES

Although ordering by pattern sizes is an established procedure with more common engineering materials, it isn't always the most economical method with titanium. For example, when small parts are to be cut from sheet, ordering "random size" will save you 75 cents per pound of material. The price allowance is applicable when *specific sheet sizes are ordered,* but shipment is permitted in widths ranging from −6″ to +2″ and lengths ranging from −18″ to +12″. Weight of random size sheets and exact size sheets of the same gage can be combined when computing quantity prices for a given order.

✶ TOLERANCE

Here important weight saving advantages are accorded designers and cost savings accrue to purchasing. Material specified ½ AISI tolerance weighs 10% less than standard-tolerance material.

TMCA's district sales manager will be happy to provide you information on grades and products where this tolerance schedule applies.

✶ WIDTH

If you determine the end use of metal before ordering, you will sometimes realize important cash savings. For example, titanium metal 24″ wide is classified as "sheet," and sheet prices apply. However, by ordering material 1/16″ less in width, strip prices apply at a savings of 50 cents to $1.00 per pound.

✶ THICKNESS

A more substantial saving is possible in specifying plate rather than sheet where the substitution meets design requirements. Metal 0.187″ thick is priced as sheet. However, metal 0.1875″ is priced as plate at a savings of $2.10 per pound.

✶ SIZE

A size extra of 20 cents per pound applies to billets 8″ or less in diameter. However, billets 8 1/16″ in diameter are supplied at base price. If the additional 1/16″ can be tolerated by design, the financial savings on material can be realized.

These are just a few examples of the money savings possible through careful study of the "price extra" sections of your Buyer's Guide.

Fixed, published schedules are vital in guaranteeing standard quotations to all customers in highly competitive work. By the same token, TMCA customers will receive every pricing benefit possible under these schedules.

* * * * * *

If you are placing an order for titanium, or considering purchase of titanium, contact the TMCA sales manager in your district. He can help save you money and time.

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- ☐ Bulletin 6 Titanium Welding Techniques

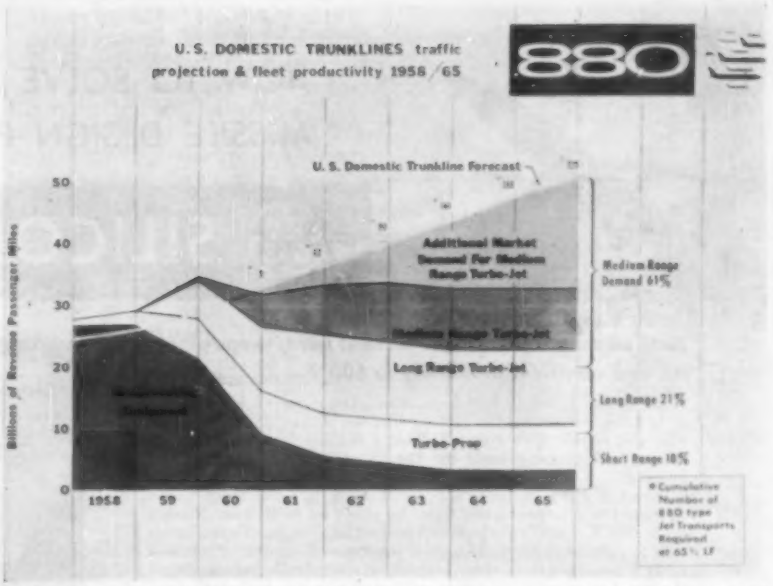
ing the shock wave due to local supersonic velocities over the wing in the inboard section. Convair found that reflex tends to unload the wing tip at high speeds and to reduce overwing velocities with the end result being a weaker-than-normal shock formation in this area.

Having developed the bodies for anti-shock purposes, Convair also found it had provided additional tankage space to extend the 600's range capabilities.

Having developed the larger, faster, longer-range 600, Convair has not neglected the 880 design. The basic airplane will be that ordered by Trans World Airlines and Delta Air Lines, but extensions of this model are under study.

One study on the 880 would result in an airplane on which some skin gages would be increased to increase strength for a payload gain, resulting in an aircraft with a maximum zero fuel weight of 117,000 lb. rather than the 113,000 lb. of the basic 880.

Convair also is talking to some European airlines about an 880 which would be capable of operating to South America, throughout Europe and to the Middle and Far East, on a consistent basis. This version is strictly in the talking stage—a proposal—and Convair top management has not yet given approval for the design or construction of the aircraft.



JET transport market forecast calls for 18 billion additional passenger revenue miles in 1965.

Convair 600 Data

WING	
Area (basic)	2,250 sq. ft.
Aspect ratio (basic)	6.2
Airfoil thickness ratio	
9.75% span	10.55%
31.51% span	8.18%
64.70% span	7.41%
tip	6.11%
Sweepback (leading edge)	38 deg. 45 min. 22.769 sec.
Sweepback (30% chord)	35 deg.
Taper ratio	0.303
Dihedral	7 deg.
Angle of incidence	4 deg.
HORIZONTAL TAIL	
Area	426.5 sq. ft.
Aspect ratio	3.52
Airfoil thickness ratio	
root	8.80%
tip	7.41%
Dihedral	7.5%
Sweepback (leading edge)	41 deg. 9 min. 30 sec.
(30% chord)	35%
Taper ratio	.286
VERTICAL TAIL	
Area	295 sq. ft.
Aspect ratio	1.518
Airfoil thickness ratio	
root	10%
tip	8%
Sweepback (30% chord)	35 deg.
Taper ratio	.33

The plane would retain 880 dimensions, but would have a gross takeoff weight of 199,400 lb. which is 20,900 lb. heavier than the basic 880, and would have a ramp weight of 200,000 lb. which has resulted in its being labeled unofficially the "200,000 lb. 880." Maximum landing weight would be 155,000 lb., up 31,500 above basic 880, while zero fuel weight would be 123,000 lb., a 10,000 lb. increase over basic 880.

A primary difference would be the addition of five wing center section fuel cells, which would give operators extended range with the 880 size, an attractive proposition to a number of airlines which cannot afford the larger and more costly 600.

Range and Speed

In selling the 600, Convair points out the range-at-speed advantages of the aircraft. Calculations have been made which indicate that on a Seattle-Tokyo run the airplane's capabilities are such that 50% of the time the flight could be made nonstop; and that if one refueling stop were made, the airplane still would arrive just 10 min. later than a competing intercontinental type jet transport which made the trip nonstop, predicated on a normal 6 hr. flight time. The nonstop 600 would, of course, be much faster. For the 600, Convair projects a 20-year service life which, the company feels, will be almost all first-line due to the airplane's speed capabilities. Items which would require change during service life to keep the airplane up to date would consist primarily of interior and exterior trim, as well as passenger comfort and convenience items.

Cost Savings

Another facet of the long first line life of the airplane, Convair says, is the money that operators will save on integration costs. With postwar piston-engine transports, new models were introduced periodically, requiring considerable expenditures for their incorporation into operations.

These amounts will be profit for the operators, Convair declares, perhaps three to four times during the life of the 600.

Structural fatigue with attendant down time on the airplane for repairs is a critical design factor in all jet transports, emphasized by the per-hour earning capacity and high utilization rate planned for these aircraft.

Going back in its Convairliner 240 program, Convair started laboratory tests on fatigue possibilities which enabled the company to not only make up kits required to repair fatigue damage in specific areas, but to have these kits in an operator's hand well prior to the first reported fatigue problem, which occurred as predicted.

The sales program for the 880 and 600 stresses that the aircraft are designed to fly the first line life without facing the fatigue problem. Contributing to the jet design was data derived by Convair research in the twin-engine

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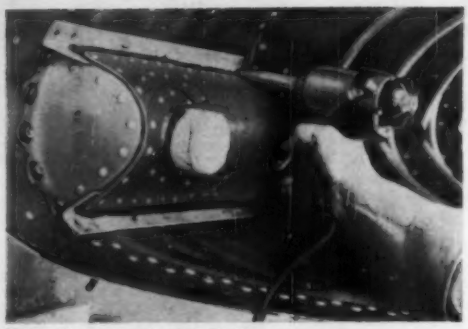
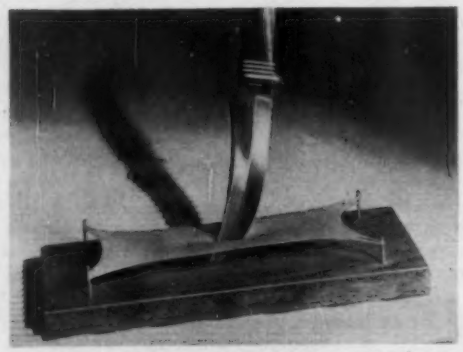


RTV sealing in Douglas DC-8 Jetliner.



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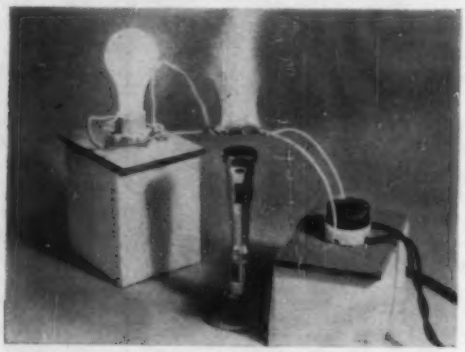

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down operations peculiar to short haul airplane were thoroughly and completely analyzed.

Data showed that of all structural loads, those resulting from taxiing dictated fatigue criteria, since a proportionately large portion of airplane operation time for a short-medium range airplane was spent in this regime where loads are reversed from those of normal flight.

Convair feels it has another design advantage in transferring knowledge from the 880 to 600.

In this case, the company is designing up to a medium range airplane from a short haul type, rather than down to a medium range plane from a long haul aircraft.

The result, Convair claims, is a more balanced design, yielding a structure based on criteria peculiar to the design mission, whereas other designs are forced to accept compromises which the 600 does not face, those that are created by chopping down a larger basic aircraft design.

Another advantage, Convair feels, lies in its use of Scotchweld bonding. This has been shown in tests to increase strength, but is not taken into account in fatigue or structural strength calculations. The bonding process also results in the unloading of fasteners such as rivets along the bonding line giving additional margins in shear and bearing.

In the battle to keep structural maintenance costs as close to zero as possible, Convair feels it has gained additional ground by applying Scotchweld primer to the entire interior surfaces of 880 and 600 wing integrated fuel tanks, since continuing research has shown the primer to have excellent corrosion resistance properties.

Additional tankage in the 600 wing center section and anti-shock bodies, plus center section fuel cells in the projected long-range 880, use bladders.

Design Cognizance

Inherent characteristics of the transport intended to fly the stages between 400 and 1,799 stat. mi., which Convair selected as boundaries of medium range operations, leave leeway at both ends of distance scale when proper design cognizance is taken, according to Convair.

This adds considerably to plane's potential market, and the company is moving to take fullest advantage of all sales possibilities.

Convair says that down to stage lengths of 200 mi., the 600 has the same seat mile costs at reasonable load factors as competitive turboprop aircraft do. The company acknowledges that direct costs are higher, more seats are to be filled, but cites a balancing speed advantage which can be offered in airline selling.

And while 600's nonstop or speed-at-range capabilities offer some airlines a potent entry in long haul operations, Convair's thinking is that still another market exists for an airplane which can operate on part of a route system as a basic medium range aircraft and needs only to have more fuel put into its tanks to send it on intercontinental trip.

Projected for this market is the "200,000 lb. 880," for which Convair cites these advantages peculiar to this design:

- **Fewer seats to fill,** which gives some foreign airlines a much better chance to board enough passengers within their own territories to make the trip pay, or at least to minimize this aspect of competition they must meet in filling planes at major international departure centers.
- **Smaller physical size,** which affects maintenance facilities requirements.
- **Lower initial cost,** but multi-mission capability.
- **Operational performance** capabilities of basic medium range airplane and their effect on runway length and strength requirements.

An expanded potential market for its aircraft has led Convair to develop techniques and services in its sales pro-

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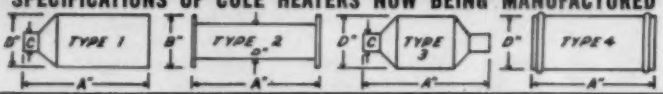

CAT. NO.	CAPACITY K.W.	VOLTAGE	RATED AIRFLOW LBS/MIN.	TEMP. RISE AT RATED AIRFLOW °F.	THERMAL LIMITER	TYPE	DIMENSIONS A	B	C	D
C-970	.6	27	1.7	82	Thermo./Link	4	6			2
C-672	.75/.37	27	5	34/17	Thermostat	4	8½			3
C-1122	1	115	15	15	Fusible Link	Blower	1½			3¼
C-665	1./.67/.33	27	5	46/31/15	Thermostat	3	8⅝			3½
C-553	2	27	6	77	Thermostat	3	9		1	2
B-1246	2	27	10	47	Thermo./Link	4	6⅞			1½
C-667	2/1.3/.7	115	3	155/115/54	Fusible Link-	2	6⅛			3
C-883	2	27	6	76	Thermo./Link	4	6			2
C-990	2	27	6	76	Thermo./Link	4	6			2
C-995	2	27	7.5	62	Fusible Link	2	2½	8		6-9/16
C-1258	2/4	27	2	230/460	Thermostat	2	10-3/16	6		5
C-660	2	115	11	42	Thermostat	4	7			3
C-726	2.1/1.05/.55	27	4	123/61/30	Thermostat	4	9½			3
C-1079	3	115/200	3	230	Thermostat	2	13	3⅛		3½
D-611	3	115/200	22	30	Thermostat	Misc.	25			7
C-561	3	115	3	235	Fusible Link	4	13			3½
C-666	3/2/1	27	10	70/47/23	Thermostat	4	10¼			3½
C-1329	3.5	115/200	40	20	Thermostat	2 (Blower)	13⅝	6-1/16		5
C-885	4	27	14	66	Thermo./Link	1	8½		2	4
C-980	4	27	6	155	Thermo./Link	4	9-15/16			2
D-312	4	27	10	94	Thermostat	1	8½		2	4
C-932	5/2.5	27	15	70/35	Fusible Link	4	9½			4
C-1082	5	115/200	15	70	Thermostat	4	15⅛			4
D-553	5/10/15	115/200	130	8/16/24	Thermostat	2 (Misc.)	20	6¾		6
C-562	5	115	15	70	Fusible Link	4	15⅛			4
C-602	6	27	10	140	Thermo./Link	4	11⅛			4
B-1413	6	27	13	108	Fusible Link	2	5⅛			3
C-747	6/3	27	15	94/47	Fusible Link	2	6⅜			4
C-662	7	27	15	108	Fusible Link	4	9½			3
C-671	7/3.5	27	50	32/16	Fusible Link	4	9½			3½
C-787	7/3.5	27	8	205/102	Thermo /Link	4	9½			3½
C-1329	7.5	115/200	18	96	Thermostat	2 (Blower)	14½	8⅞		7¾
C-607	9	115	4	525	Fusible Link	4	15			4
C-648	9	115	8.33	255	Thermostat	4	15			4
							Length	Width		Height
A-7385	.05	27	Conduction	920°F	—	Flat	1½	1.7		⅜
A-6645	.058	27	Conduction	920°F (60W/IN²)	—	Tube	3			½
A-6649	12	27	Conduction	1000°F	—	Flat	2¾	2		⅜
D-608	1.15	115	Conduction	170	Thermostat	Water	13½			
C-1319	3	115/200	22	30	Thermostat	Misc.	27	11⅞		6
C-1278	10	115/200	30	70	Thermostat	Misc.	10	8		7⅛
C-1320	27	115/200	170	36	Thermostat	Misc.	27	11⅞		6
C-1271	30	115/200	150	46	Thermostat	Misc.	25	16		4

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gram which delve deeper than usual into certain aspects of prospective purchasers' problems.

Although generally Convair follows what has become fairly common practice among jet transport manufacturers in trying to help potential customers find suitable markets for surplus equipment, and in furnishing route studies and operational techniques data which can be submitted to possible financing sources, the company has carried its efforts further in the financial advisory field than is common practice.

In the past, many purchases of American equipment have been financed through the U. S. Export-Import Bank, as a normal practice for foreign flag carriers which are not necessarily owned or sponsored by their governments.

For airlines which can use this or other conventional sources for financing, Convair performs the usual services. Arrangements here call for dollar or sterling loan payments.

Finance Source

Although creation of expansion of civil transport fleets is not considered to fall under its aegis currently, the U. S. Development Loan Fund may become a new potential financing source for some foreign flag carriers. This agency makes long term loans to underdeveloped countries for projects which will require extended periods of time to complete. Establishment of an air transportation system could well come under such project category, even though it does not now meet loan eligibility requirements. This agency can accept local currencies in repayment, a factor which can have a tremendous influence in view of trade relationships and balances which many smaller nations have with the dollar and sterling countries.

Soft currencies present a problem, Convair finance experts realize, but the company's latitude in operational thinking indicates that quite possibly something can usually be worked out. The direct barter system has not yet entered the picture, but arrangements wherein barter would figure, with the end product being dollars, pounds sterling or other acceptable currency to exchange for airplanes, are not impossible.

As for the used airplane market, which some foresee as a bad situation when jets really start flowing into operation, Convair experts indicate it may not be as bad as anticipated. Although they say they are not able to tell today where one might sell five or 10 DC-7s or Super Constellations, they claim, when the time comes, the used plane market problem may well not be as severe as anticipated.

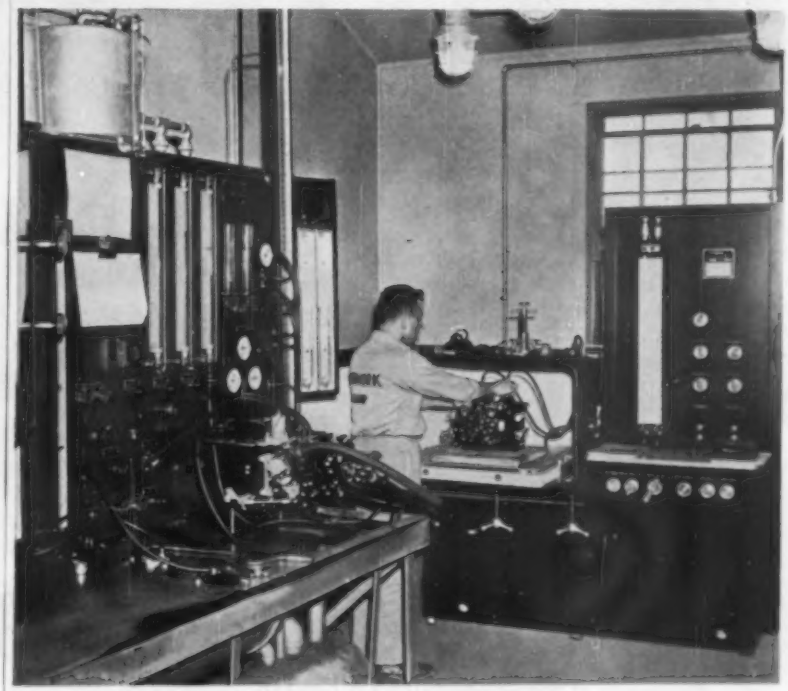
For the financial community, Convair has developed a presentation which is keyed to its medium range aircraft and the attendant inherent economics not tied to any airline's operations. This promotion tool can be used to tell effectively Convair's story to any segment of the financial community, and may create favorable impressions which will bear fruit later with people who have no involvement in aeronautical aspects of finance at the moment.

Another area where Convair finance people are at work is in making initial contacts with leasing companies—firms which buy and lease to operators all kinds of hardware, not necessarily airplanes alone, or perhaps have never dealt in aircraft of any kind before.

Although many airlines are still shy of leasing operations, a recent American move in leasing engines for the 600 and Lockheed Electra indicates that at least some of the advantages of this particular system of doing business have appealed to an operator.

Lease operations are just now coming up in the field, Convair people find, and as the various facets of this method in relation to capital requirements, tax outlays, and over-all financial position become clearer, an upsurge may result.

(This is the first of two articles on the Convair 600. The second will appear in next week's issue.)



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SAUNDERS-ROE P.531 five-seat general purpose helicopter was built as a private venture. Rotor diameter is 32 ft. 6 in.

Turbine P.531 Aimed at Export Market

Farnborough—Saunders-Roe's P.531 gas-turbine helicopter is Britain's latest bid for export sales in the rotary-wing field.

The new P.531 carries a pilot and four passengers in a compact airframe with a 32½-ft. diameter rotor. Powerplant is a Blackburn Turmo 2 (license-built equivalent of the French Turbomeca Turmo 2) rated at 425 shp. for one hour maximum time.

P. 531 is roughly comparable to Sud Aviation's Alouette or the Bell 47 series, except that it is heavier at its 3,800 lb. gross than either craft, and it is physically smaller than both.

Time scale of the project raised some eyebrows in Britain: from detail design to first flight took 200 days. The project was first begun last November and finished by the year's end. Detail design began with the new year. Ground runs began June 19 and first flight was July 20.

Private Venture

The company is financing the construction of three prototypes as a private venture. Even though the design draws heavily on Saunders-Roe experience with its Skeeter series of agile helicopters built for British and West German military services, the major portion of the project was in new areas. Financial risk for the company, which suffered when its P.177 mixed-power interceptor never got off the assembly floor, must be considerable.

First photos of the P.531 show a rough-and-ready airframe devoid of refinements of line and aesthetics of form. The Blackburn Turmo and its assorted plumbing, intake and exhaust ducting seems to have been flung on a shelf behind the passenger cabin. But this is simply a prototype and there is the prospect that final versions of the craft will more nearly resemble the handsome little Skeeter.

Seating Arrangement

Pilot and one passenger sit side-by-side at the front of the cabin and behind them is a bench for three passengers. This bench folds flat against the wall to leave the area clear for freight or to take two standard service stretchers for air evacuation or ambulance tasks. The seat next to the pilot is reversible so that a medical attendant, if he wishes, can turn to face his patients.

An air-operated lightweight Lucas hoist is fitted for rescue work. Slings or cargo nets can be attached to the bottom of the fuselage for carrying bulky loads externally.

Rotor system is based on a constant-speed rotor and turbine control system which can be pre-set to hold a desired rpm.

Main rotor is four-bladed and so far has shown low vibration levels and control forces, says the company.

The Turmo is a free-turbine type of powerplant, which means the transmission is clutchless. It burns standard commercial fuels—kerosene, light diesel oil or low-octane gasoline.

Built-in Growth

Growth has been built into the craft because rotor, transmission system and fuselage have been designed to take the stresses of new Turmo developments with shaft horsepowers up to 650. In addition, the company says an operator could install gas turbines in the 800-1,000 shp. range, and derate them for sea-level operation at a reduced power level which could be held constant to a high altitude or temperature.

Project team was led by Saunders-Roe's chief helicopter designer, T. L. Ciastula. First flights were done by chief helicopter test pilot K. M. Reed.

Saunders-Roe P. 531 Specifications

Over-all length, main blades folded	29 ft. 0 in.
Over-all width, main blades folded	8 ft. 6 in.
Over-all height	9 ft. 6 in.
Main rotor diameter	32 ft. 6 in.
Weight empty	2,092 lb.
Gross weight	3,800 lb.
Useful load	1,708 lb.
Maximum range, normal tankage	210 naut. mi.
Maximum endurance, normal tankage	3.3 hr.
Maximum range, long-range tankage	280 naut. mi.
Maximum endurance, long-range tankage	5.2 hr.
Cruising speed	100 kt.
Maximum speed	105 kt.

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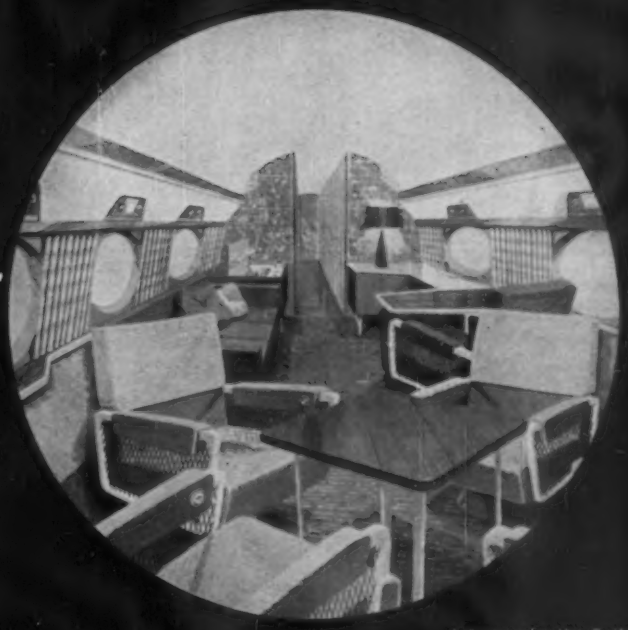

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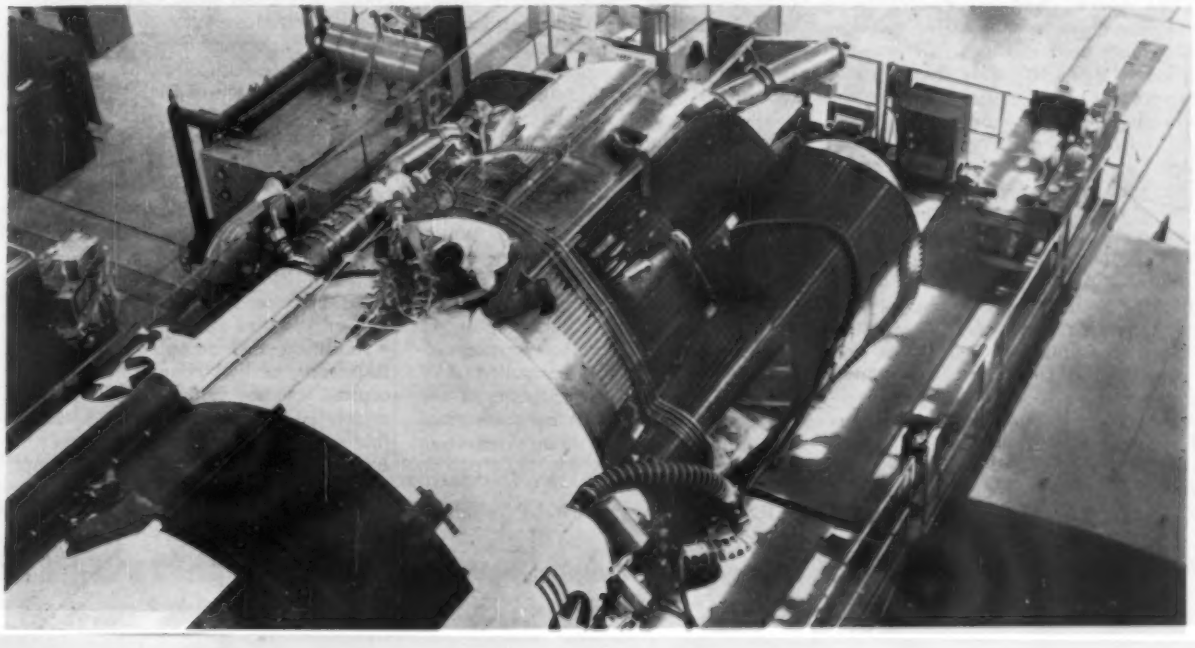
SPACE TECHNOLOGY

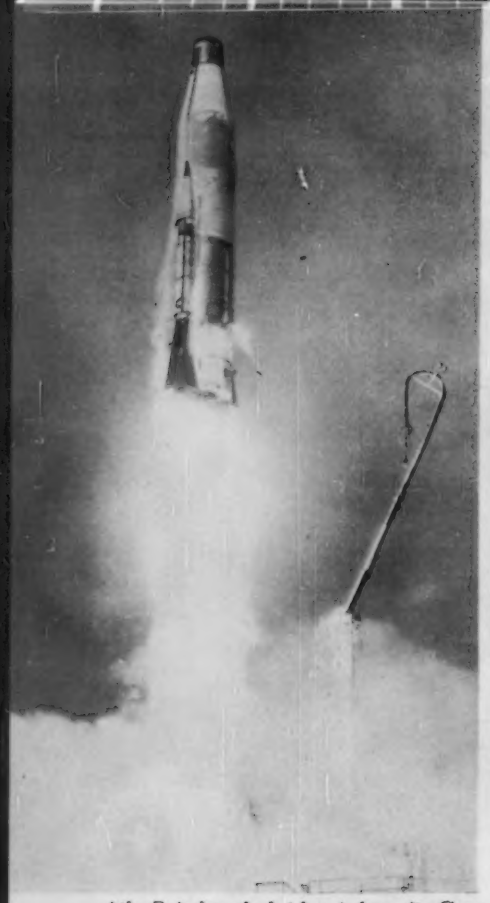
Long nose probe is installed on Douglas Thor, shown seconds after launching. Note twin sensors mounted midway on probe.

Thor is fitted with new production nose cone in this night view of missile. Note power line tower.

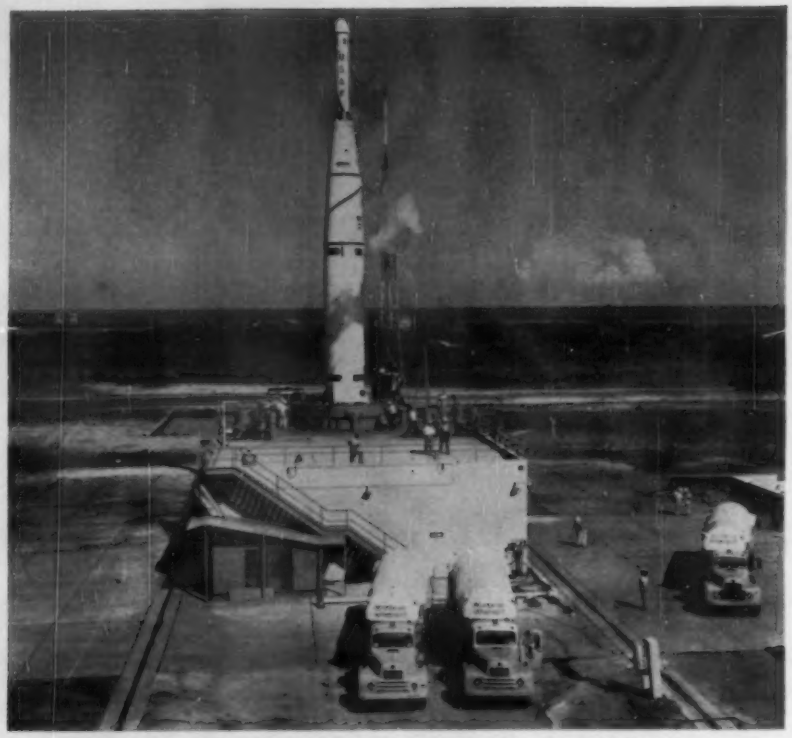
Final version of the USAF-Convair Atlas intercontinental ballistic missile could operate with a second stage of 40,000 to 50,000 lb. total weight without extensive modification, making it useful for a wide range of space vehicle applications. Mass ratio of current vehicles is being improved by shaving weight of many of the parts. During firing last September, in which the missile gyrated violently for a number of seconds before breaking up at low altitude, missile exceeded design loads considerably. First successful three-engine firing of an Atlas-B last Aug. 2 proved staging, nose cone separation and ground guidance operation. Nose cone was separated just after burnouts. Body of missile was backed away from the nose cone by two retro-rockets. Single retro-rocket can accomplish the job alone. Firing of these rockets does not disturb the trajectory of the nose cone, which has been determined earlier by guidance in the main missile body. Vehicles being fired in the current series of three-engine tests are heavily loaded with instrumentation. Although they carry full fuel load and engines run to burnout, the payload-overload of telemetry equipment cuts the mass ratio enough to cut range from more than 6,000 mi. to some 2,500 mi. General Electric Co., nose cone contractor for the Atlas, has developed a recoverable data capsule that can be used to back up telemetry. Greatest vibrational stresses experienced by Atlas cone during the time that the missile is being held on the test stand. When engines reach 90% of maximum thrust, missile is automatically released for flight. During flight, most of the vibrations are damped out by the atmosphere. Missile's stainless steel outer skin is constantly under high stress, due to a great deal of internal pressurization, providing considerable strength with light weight for the Atlas.

Atlas-B gets final inspection in modification hangar. Vernier engine thrust tube is at technician's right.





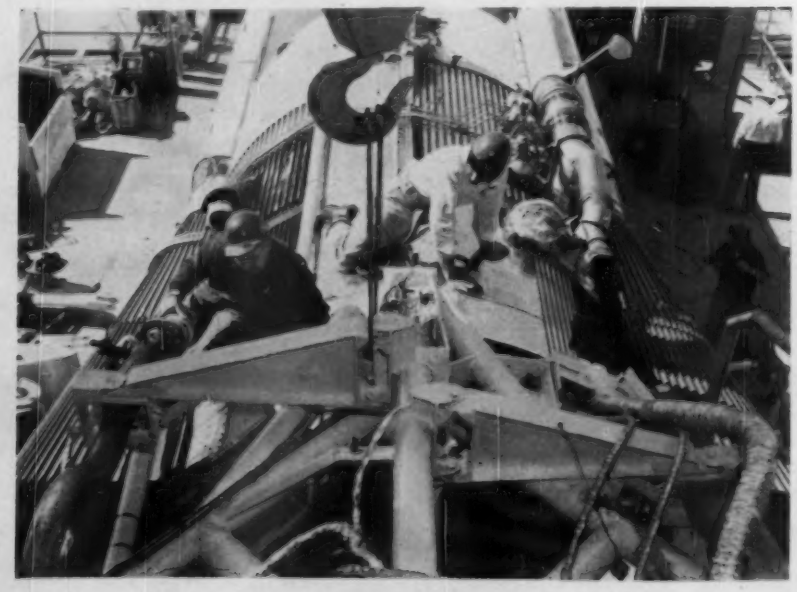
Atlas-B is launched (above) from its Cape Canaveral launching pad (below). Checked pattern on aft section is for camera sighting.



Fuel trucks are positioned at Thor-Able launch pad as vehicle is readied for firing.

Weight Reduction Drive Increases Atlas-B Tactical, Space Missions

Workmen line up fittings as Atlas-B moves onto the launch pad A-frame.



nique, called Automatic Bandwidth Control, retains the full FM improvement advantage but minimizes the threshold effect by automatically varying the bandwidth by a factor of 10, was developed by two Collins Radio Co. engineers.

• **Crossed field** traveling wave tube. New type of crossed field traveling wave tube, called the M-J tube, has been developed by two engineers of the General Electric Co. (Palo Alto, Calif.). Advantages of the M-J tube operation as compared with M type tubes are the collection of the electron stream on an electrode separate from the slow wave circuit and a high gain rate similar to O type tubes.

These differences may improve both power and frequency capability as well as in total gain compared with present M type devices.

Parametric Amplifiers

Until about two years ago, the only available amplifiers at microwave frequencies were electron beam devices such as traveling wave tubes and klystrons. These tubes are noisy because the electrons forming the beam are emitted randomly from a heated cathode. Theoretically, this process sets a minimum value to the attainable noise figure for tubes of this kind.

More recently, however, the old idea of parametric or variable reactance amplification has been applied to microwave amplification. Output power comes from a local source of RF energy called a pump, which is usually at a higher frequency than the signal, rather than from a d.c. electron beam. First applied to ferrite and semiconductor amplifiers, it can also be applied to electron beam devices.

Primary interest of this type of application is that, in principle, beam noise does not set a lower limit to the noise figure as in conventional tubes.

Simplified description of the operation of a parametric amplifier has been given previously for the case of a silicon diode (AW Aug. 4, p. 69). Configuration of a regenerative electron beam amplifier differs, but its operation is similar to that of the low frequency traveling wave tube discussed there.

RF Voltages

In this type of amplifier, a main cavity has two gaps separated by a field free drift space. At resonance the RF voltages at the gaps are equal and in phase. If an electron beam is passed through the cavity, then velocity modulation at the first gap will produce an RF current at the second gap.

Since an RF voltage already exists there, the result will be an electronic admittance in parallel with the cavity shunt capacitance. The phase of the gap current relative to the voltage, and therefore the character of the electronic admittance, is controlled solely by the drift angle of the electrons between gaps.

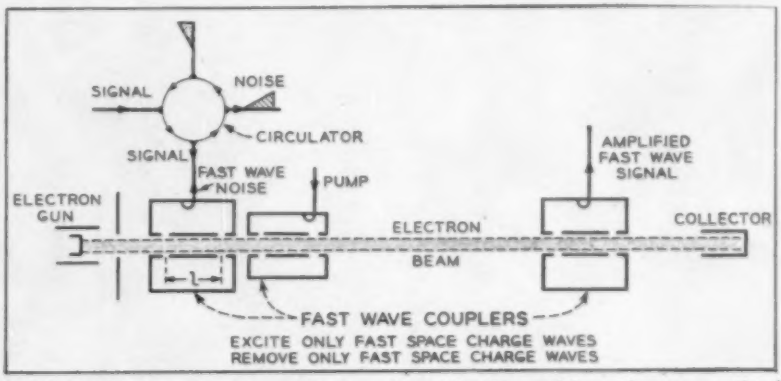
If the drift angle is adjusted to give a purely inductive or capacitive susceptance, it can be used to obtain parametric amplification. Pump modulation of the susceptance is accomplished by modulation of the beam current, which is done by means of a cavity resonant to the pump frequency and preceding the signal cavity.

Potentially large bandwidth and stable operation of a traveling wave device make it attractive as an application of the parametric amplification technique.

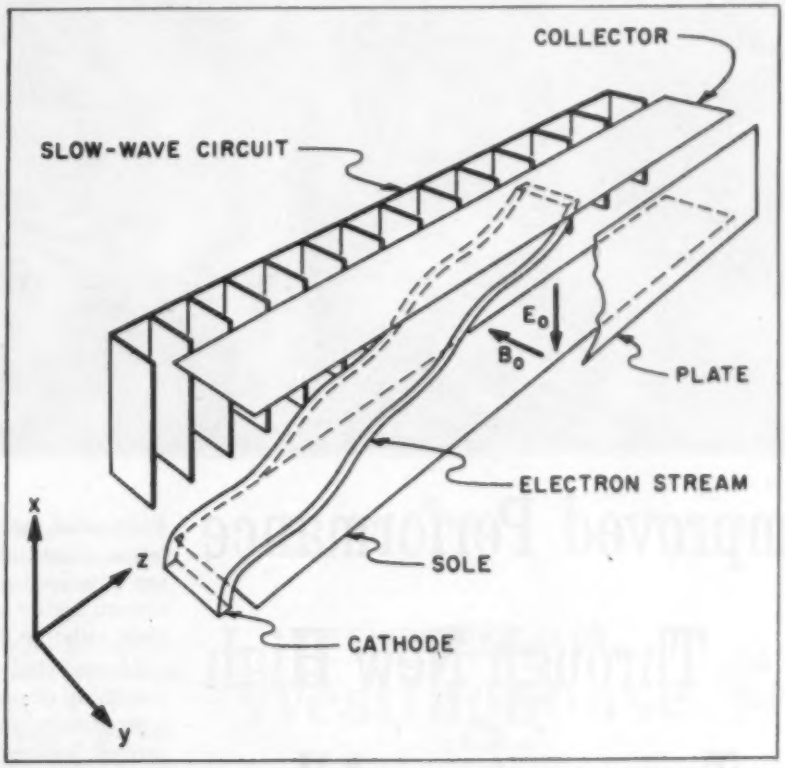
Possibly the two-cavity device just described could be repeated to form a traveling wave structure but a better method is available.

By simultaneously applying a signal wave and a pump wave to an electron beam, the signal can be made to grow exponentially without any surrounding circuits.

Space charge waves on an electron beam are similar in many ways to waves on a transmission line—where two waves are possible, one traveling in the for-



PARAMETRIC electron beam amplifier is version of familiar amplifier without conventional noise limitations, employing fast wave amplification without fast wave noise.



CROSSED field traveling wave tube, called M-J tube, has advantages of collecting the electron stream on an electrode separate from slow wave circuit and a high gain rate.

EIGHT-ELEMENT broadside array constructed by Stanford University scientists for beyond-the-horizon propagation studies at S-band employs helical feeds which rotate to provide phase shifting action that causes main beam to rapidly scan a 4.2 deg. azimuth sector.

Moon Reflectivity Described at Wescon

By James A. Fusca

Los Angeles—Subjects ranging from reflection characteristics of the moon as they affect earth-moon-earth communications systems to handy short cuts in engineering report writing, covering the breadth of the electronic and avionic arts, have been presented in technical papers delivered here at the Western Electronic Show and Convention.

One effect of this broad coverage, apparently, has been that engineers have been attending fewer presentations, concentrating mostly in areas of special interest. Proportionate number of engineers visiting exhibitors' booths has been appreciably higher than last year.

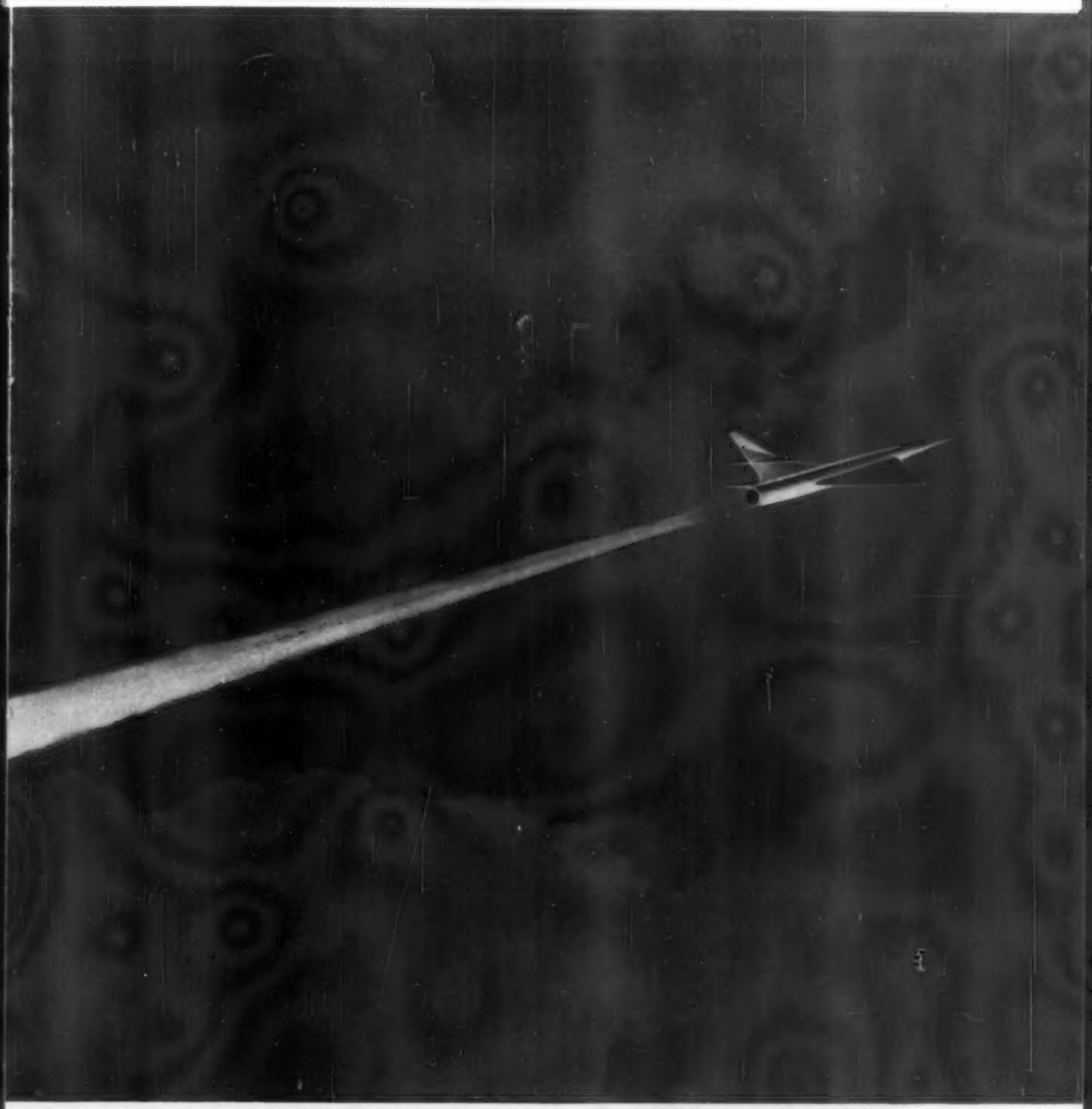
Among the papers that have aroused interest are:

• **Parametric electron** beam amplifiers. Fundamental noise limitations of conventional beam tubes do not apply to tubes employing the principles of parametric amplification at microwave frequencies, according to four Bell Telephone Laboratories scientists. They have built both regenerative (resonant cavity) and distributed parametric beam amplifiers which exhibit very low noise performance. They propose a version of the distributed type of amplifier for fast wave amplification with fast wave noise removed. (Similar device was developed by Zenith (AW Sept. 1, p. 64.)

• **Moon's reflection characteristics.** Using the moon as a means of communication between widely scattered points on the earth's surface has received increased attention since the first successful voice-relay experiments in 1954. (See description of Navy's Washington to Pearl Harbor moon-bounce communications system now being installed: AW Aug. 25, p. 15.) Two scientists of the University of Michigan have described the influence of the moon's reflection characteristics on its use as a passive relay.

• **Rapid-scanning S-band** broadside array. Beyond-the-horizon propagation experiments at Stanford University to obtain data about propagation anomalies in the troposphere have required the design and construction of a rapid scanning S-band antenna array with interesting characteristics. Eight broadside parabolic reflectors are fed by helix radiators with local ground planes so that radiated (or received) signals are circularly polarized. By mechanically rotating the helices at multiple rates, phase shifting is accomplished which causes the array to produce a 0.5 deg. in azimuth beam which continuously scans a sector 4.2 deg. in width at a rate of 10 scans per second.

• **Improved FM reception technique.** Reliability of FM communications reception can be improved by approximately 10 db. by means of a technique that proportionately reduces the receiver bandwidth as the input signal level drops toward a level which would normally produce the threshold effect. Tech-



techniques. A nickel-chromium-tungsten alloy, Nicrotung has the best high-temperature strength of known super-alloys and may be cast readily into intricate shapes.

These are two examples of Westinghouse leadership in metallurgy for improved airborne propulsion system performance.

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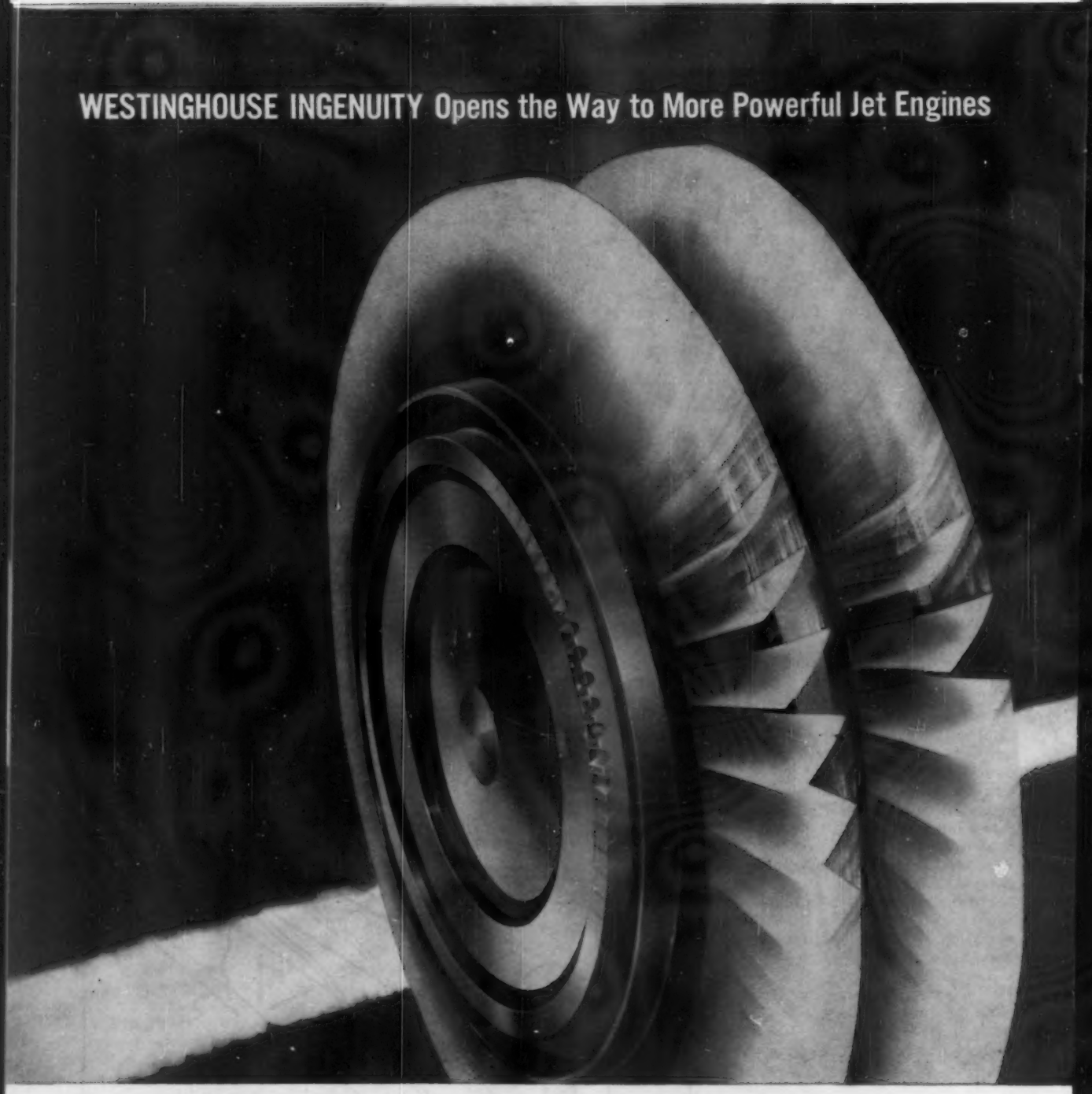

Improved Performance Through New High Temperature Alloys

Fabricated molybdenum and Nicrotung, two of the latest Westinghouse metal miracle developments, are outstanding examples of metallurgical progress toward higher operating temperatures and more efficient airborne propulsion systems.

Inconel-clad molybdenum can be used in air-breathing engines without deterioration from high-temperature oxidation. "Clad-moly" parts have proved successful in extensive engine testing at temperatures above 2000°F.

Nicrotung is a new turbine blade alloy invented by Westinghouse through the use of "predesign"

ward direction, one traveling backward. In an electron beam the velocity of propagation of the space charge waves is much less than the beam velocity. Therefore, instead of a forward and backward wave, a fast and a slow wave can exist. The fast wave travels slightly faster and the slow wave slightly slower than the beam velocity.

Either or both of these waves can be amplified by simultaneously applying the corresponding wave at the pump frequency. If the pump frequency differs from twice the signal frequency, an idler frequency appears that grows with the signal wave.

Fast Wave Amplification

In conventional velocity modulation tubes such as klystrons and traveling wave tubes, it is the slow wave that is amplified. Theory shows that it is impossible to remove noise in the slow wave from the beam, accounting for the inherent noisiness of such tubes. In contrast, the noise in the fast wave can be removed, but no way of amplifying the fast wave was known. Most important aspect of the device described is its ability to amplify the fast wave.

While noise in the slow wave which would naturally couple to the output could be removed only by adding noise power to the beam in exactly the correct phase and amplitude—obviously impossible—noise in the fast wave can be absorbed from the beam by a passive circuit, because the output power comes from the RF pump and not from the d.c. beam.

Of the possible methods for exciting and extracting the fast wave only, the one proposed by the Bell Telephone Laboratories' scientists (A. Ashkin, T. J. Bridges, W. H. Louisell and C. F. Quate) is illustrated in the accompanying sketch.

Double gap cavities are used as fast wave couplers which—if correctly spaced in terms of plasma and electronic wavelength and if the shunt conductance of the cavity is adjusted to the correct value—will cause the device to act as a directional coupler so that:

- **Power input** to the cavity will excite the fast wave only on the beam output.
- **Fast wave** on beam at input will all be absorbed by the cavity and its load.
- **Slow wave** on beam at input will pass through the cavity unchanged.

First cavity will remove the noise in the fast wave and also apply the signal to the beam in the fast wave. Noise and signal are separated in a circulator. Second cavity applies pump power to the beam in the fast wave. After the region where exponential gain occurs, an output cavity extracts power from the fast wave, while the slow wave noise passes through unchanged.

In principle, removal of fast wave

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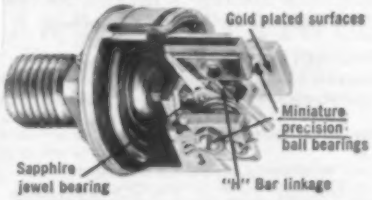

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		Linearity	±1.0%
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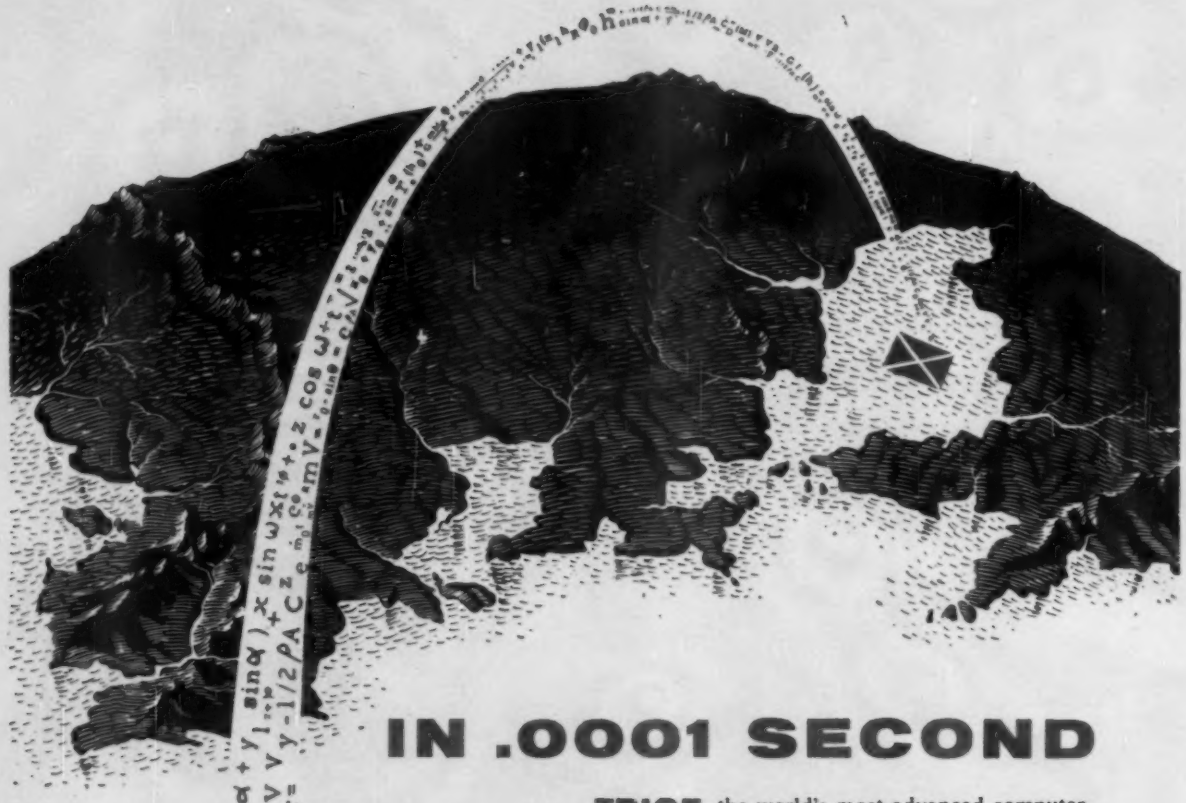

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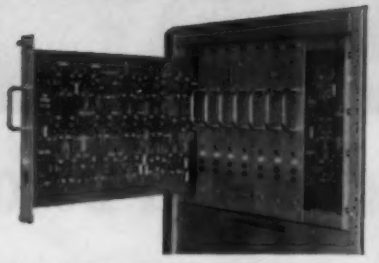

ENGINEERING BEYOND THE EXPECTED

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more than 3 db. Therefore, assuming the radar cross-section of the moon to be independent of wavelength, from this point of view also a short wavelength is desirable.

Because only the central portion of the moon's surface, an area less than one third of the moon's radius in extent, is responsible for the return signal, it is necessary to illuminate only this part of the surface with the transmitted signal. Therefore, power can be conserved by using a very narrow beam, of course more easily achieved with smaller antennas at shorter wavelengths. At the earth, the moon subtends an arc of approximately 0.5 deg. so that a 0.1 deg. antenna beam will be adequate with proper tracking. Because of the regular predictable motion of the moon through the sky, tracking is not difficult in principle. It would take a 60 ft. parabola to provide a 0.1 deg. beam at a 3 cm. wavelength.

S-Band Array

Beyond-the-horizon propagation studies at Stanford University required construction of an S-band receiving antenna with a narrow azimuthal beamwidth which could be scanned rapidly over a limited azimuth sector. Purpose of the antenna was to study the influence of the lower levels of the atmosphere on microwave signals propagated to distances well beyond the horizon.

A broadside phased array was selected for this purpose because even at 3,000 mc. an antenna with an 0.5 deg. beamwidth becomes large (40 to 50 ft. in diameter), and difficult to manipulate in time intervals of a fraction of a second. Because signals of interest in this type of propagation experiment arrive within an azimuth sector only a few degrees wide, the sector scanning feasible with a phased array was acceptable.

Antenna, as designed, therefore, was an eight-element broadside array using 3.5 ft. parabolic reflectors. Small helical antennas were used as primary feeds, and additionally act as phase shifters to produce the scanning action.

The main lobe of the array is scanned through the 4.2 deg. azimuthal sector by advancing (or retarding) the phase of the signal at each element relative to the next adjacent element of the array by 360 deg. The required continuously variable phase shifter is obtained by employing two circularly polarized radiators, one acting as a transmitter and one as a receiver.

One characteristic of such an antenna which converts linear to circular polarization is that, at a fixed reference plane in space normal to the direction of propagation, the angular position of the vector at a fixed instant in time depends upon the angular position of the antenna. Therefore, if one antenna is held fixed and the other rotated, the phase of the linearly polarized wave at the output of the receiving antenna will vary as a function of the angular position of the rotating antenna.

In designing the array, rotatable helical antennas were used to avoid constructing both separate feeds and separate phase shifters for each element. With the antenna at the other end of the transmission path circularly polarized, rotation of the helical feeds with the proper speed relationship will cause the main lobe of the array to scan continuously through the desired angle.

To scan the sector 10 times per second the difference in relative phase shift and in mechanical speed of rotation must be 10 rps. or 600 rpm. Therefore, the four elements on one side of the array, beginning at the center, will rotate clockwise at speeds of 300, 900, 1,500, and 2,100 rpm. respectively, while the four opposite feeds will spin at the same relative speeds in a counter clockwise direction.

In general, frequency modulation is preferable to other types of modulation for multichannel high-quality communications such as are required in using the technique of tropospheric scatter. Use of wide bandwidths in FM systems results in a higher demodulated signal to noise ratio than is attainable in conventional amplitude modulated systems, provided the received signal exceeds a certain value determined by receiver parameters termed the threshold level.

At UHF frequencies where tropospheric scatter is most adaptable, cosmic and atmospheric noise is negligible compared to thermal noise generated within the receiver. If the receiver signal input level exceeds the threshold value, the output signal to noise ratio is directly proportional to the input level. However, as the input value falls below the threshold value, the output signal to noise ratio deteriorates very rapidly.

Propagation Losses

The high median propagation losses and random fading that characterize tropospheric scatter circuits conventionally are compensated for by use of high power transmitters, high gain antennas and sensitive receivers to produce a signal level that exceeds the threshold value for a percentage of time consistent with adequate reliability.

Many communications problems, however, including economic ones, cannot be satisfactorily solved with conventional FM systems. H. D. Hern and M. S. Ulstad of Collins Radio Co. have proposed a method of improving FM reception based upon enhancing the performance of a receiver during the period when the input signal level falls below the receiver's conventional threshold value. The method results in effect

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noise could be perfect, resulting in an amplifier where no noise is contributed by the beam. In practice, however, noise removal will not be perfect and other mechanisms probably will contribute to degrading the performance of the amplifier. These questions are to be the subject of further experiment.

Moon Reflection

Possibility of using the moon as a passive relay for communications between widely separated points on the earth's surface explains much of the current interest in its scattering properties at microwave frequencies. A paper presented by T. B. A. Senior, K. M. Siegel and H. Weil, of the University of Michigan, describes work performed under a contract for Rome Air Development Center.

Range of useful wavelengths for moon communication is bounded on one side by limitations imposed by ionospheric attenuation and meteor scattering, and on the other side by attenuation due to absorption by atmospheric oxygen and water vapor. Theoretical values for this absorption indicate that 3 cm. should be the lower limit in wavelength.

Results of the University of Michigan studies point to operating at as short a wavelength as possible. One reason is that a major factor in the design of such systems is the desire to obtain received pulses of a regular and consistent shape with a minimum of frequency distortion. Because the moon appears to act as a smooth rather than a rough scattering surface, FM communications systems should operate at very short wavelengths and employ only the initial portions of the received pulses, or pulses no longer than five microseconds, to minimize frequency distortion.

Other Advantages

There are several other advantages to be gained by use of short wavelengths. Ionospheric effects are reduced drastically as the wavelength is decreased, as are the disturbances due to meteor trails and Faraday rotation of the plane of polarization.

Faraday rotation evidences itself as a systematic fading of a linearly polarized signal and can, if necessary, be avoided by using circular polarization. The rotation, however, decreases with increasing frequency and is considerably less than one degree at 10,000 mc.

In some earlier work, it was felt that the reflection coefficient of the moon would fall off appreciably at short wavelengths—one of the reasons that some original recommendations were for wavelengths in the order of one meter or more. Experiments have shown that the reduction is comparatively small, no

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• **Sub-miniature tantalum capacitors,** sintered anode type, for operation over temperature range of −80C to 85C,

reportedly meet environmental requirements of MIL-C-3965. Units are available in capacities of 47 mfd. at 6v. and 6.8 mfd. at 35v. Bulletin TQ-30 gives application data. Minitronics Corp., 328 Grand St., New York 2, N. Y.

• **Miniature transistor** servo amplifier, Model 501-1, provides ¾ watt output, voltage gain of 150, input impedance of 20,000 ohms. Unit occupies volume of only ¾ cu. in., requires 60 ma. of 28 v.d.c. power for full output, employs silicon transistors. For descriptive literature, write for Bulletin 501-1 to Librascope Inc., 808 Western Ave., Glendale 1, Calif.

• **Multi-channel electronic switch,** Type ES-141, can be used to display four wave forms simultaneously on a single oscilloscope. Unit cycles at 500 kc., permitting approximately 2 microseconds per position. The Newton Co., Multi-Channel Switch division, Manchester, Conn.

• **Noise source,** covering range of 250 to 2,500 mc., for testing radar receivers and amplifiers, has VSWR below 1.3, excess noise power ration of 16.4 db., according to manufacturer. Price is $395, includes power supply and noise source with N-type input-output connectors. Radar Design Corp., 3309 James St., Syracuse, N. Y.

• **Silicon zener diode,** double anode type, rated 600 mw. dissipation, is available in zener voltage ranges from 4.3 to 30 v. to provide symmetrical dynamic clipping. Unit measures only 0.688 in. long, is hermetically sealed, designed for printed circuit board mounting. Bulletin SR-254 gives application data. International Rectifier Corp., 1521 East Grand Ave., El Segundo, Calif.

• **Transistors,** in a variety of new types have been introduced by Texas Instruments Inc. Types 2N1005 and 2N1006 are high-speed silicon switching transistors, with switching times as low as ¼ microsecond, with d. c. beta values of 20 to 55 and 45 to 150 respectively, both designed for operation at temperatures between −55C and 150C. Four new silicon intermediate power transistors, NPN types rated 40 watts dissipation at 25C. Beta value spreads of 12 to 36 or 30 to 90 are available in either the 120 v. 2N1048 and 2N1050, or the 80-volt 2N1047 and 2N1049. Also available is new 1N1821 series 10-watt double-anode silicon voltage regulator and 1N747 series 400 mw. glass reference zener diode.

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in the lowering of the threshold value during the period of the fade.

This is accomplished by proportionally reducing the receiver bandwith when the input signal level falls toward the level which would normally produce the threshold effect. The technique employs a method of automatically varying the bandwidth by a factor of 10, and thereby increasing communication reliability by approximately 10 db. Proportional combining methods have been developed for receiving systems using this technique. The authors have tested the technique over experimental tropospheric scatter transmission circuits with good results.

M-J Traveling Wave Tube

A new type of traveling wave tube that shows considerable promise for high power and high frequency performance has been described by C. C. Johnson and C. K. Birdsall of the General Electric Co.

The tube is a crossed field device in which the electron stream drift is not toward the slow wave circuit, as in the M type tube, but parallel to the circuit. The M-J circuit is put in the plane of the ordinary end hat of the (linear or circular) magnetron, and a collector electrode is substituted for the usual circuit.

In operation, the electron stream flows near the circuit and gives up energy to the circuit waves, but the electron stream is not collected on the circuit, as in the M type, but on a collector which can be made to dissipate considerable power.

Tube Similarities

Similarities and differences between the structure of the M and M-J type devices can be seen in the accompanying sketch, which shows a linear M-J tube with an injected stream. Circular models and emitting soles also are possible. The electron stream interacts with the circuit waves, and are deflected as shown. The transverse RF electric field causes the beam to snake with the stream moving closest to the circuit in a retarding electric field if the average stream velocity is made larger than that of the wave. In this case, there is a net loss of energy from the stream and consequent gain of energy by the circuit waves. Those electrons giving up energy move to a region of higher potential and thus maintain their longitudinal velocity.

A principle advantage of the M-J type of device is in the use of a separate collector, as in O type tubes. The collector may be made to dissipate much larger quantities of heat than can the circuit, opening the possibilities of higher power levels and higher frequencies.

FILTER CENTER

▶ **"Molectronics" Conference Scheduled**—First national conference on molecular electronics (Molectronics)—using fundamental properties of materials to perform functions that now require electronic circuits—will be held Nov. 13-14 in Washington, D. C., at Hotel Statler. Conference is sponsored by National Security Industrial Assn. with cooperation of Air Research & Development Command which is vitally interested in stimulating interest and efforts in molectronics (AW June 2, p. 64). Reservations, which will be accepted on first-come, first-served basis, are made with National Security Industrial Assn., 1107 19th St. N.W., Washington, D. C.

▶ **"Tell Us Your Problems"**—Companies with new ideas for airborne collision avoidance systems or proximity warning indicators, who seek Airways Modernization Board funds for development, should be prepared to point up possible shortcomings and problem areas of their technique that need further investigation and not merely cite potential advantages, according to an AMB spokesman. Although AMB has no specific funds budgeted for collision avoidance system developments, other than current program with Bendix Radio, funds might be made available if new ideas are sufficiently promising. Men to contact in AMB are John Weber, chief of Data Acquisition Division, or Robert Buck, project engineer on air collision avoidance systems.

▶ **Another Hot One**—Another hot competition in the offing is USAF's procurement of several thousand improved model airborne Tacan receivers. Companies expected to bid are Collins Radio, Federal Telephone and Radio, Hoffman Electronics, and Stromberg-Carlson.

▶ **Fourteen Bid For TRACE**—Airways Modernization Board received proposals from 14 bidders for development of Taxiing and Routing of Aircraft Coordination Equipment (TRACE), intended to speed the flow of airport surface traffic. List of bidders includes: Airborne Instruments Laboratory, Barrett Electronics Corp., Bell Aircraft, E. W. Bliss Co., Cleveland Pneumatic Industries and Sparton Electronics (joint bid), Franklin Systems, General Electric, General Railway Signal and Radio Corp of America (joint bid), International Telephone & Telegraph Laboratories (Federal Telecommunication Laboratories), Link Aviation, Melpar, Motorola, Philco and Tasker Instruments Corp.

AIR ARMAMENT DIVISION

SPERRY GYROSCOPE COMPANY

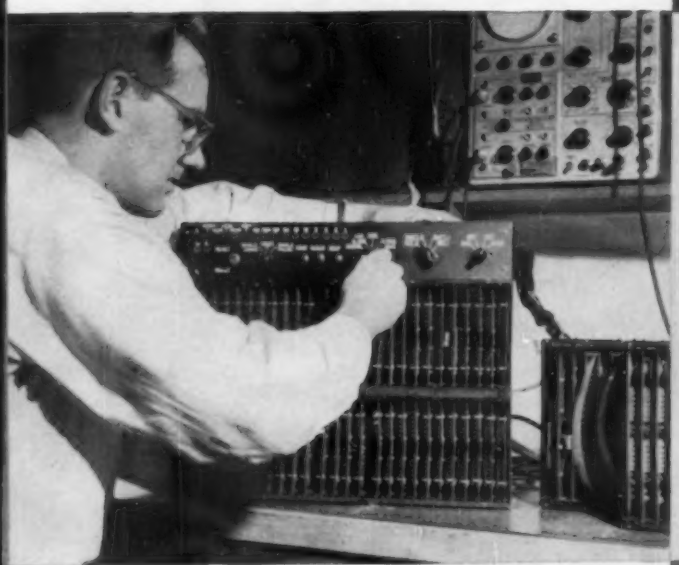
Great Neck, New York

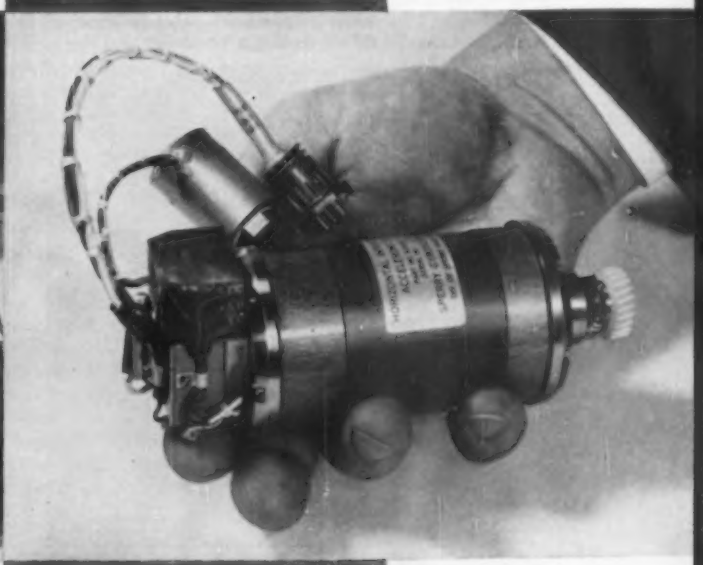
DIVISION OF SPERRY RAND CORPORATION

UNDER MICROSCOPE. Sperry employee assembles floated gyros under specially-designed hood and in sealed pressurized room. Since even dust speck might cause serious error in a long-range mission, every precaution is taken in the production of these critical units.

COMPACT Sperry stable platform mounts three advanced floated gyros. Nerve center of the inertial system, platform serves as fixed space reference in flight for maintenance of prescribed course.

NEW linear integrating accelerometers weigh only 1½ lb., measure exact velocity of aircraft or missile in any direction. New sensing mechanism moves in straight line, eliminating errors inherent in previous types.





ENGINEER TESTS new airborne digital computer designed by Sperry. Computer accepts data from stable platform's gyros and accelerometers, gives instructions for automatic corrections in flight path. Closely related operator displays permit inflight monitoring and control.

ULTRA-SENSITIVE floated gyroscope minimizes random drift assuring high performance for inertial system over long periods. These production gyros withstand shock and vibration many times the force of gravity.

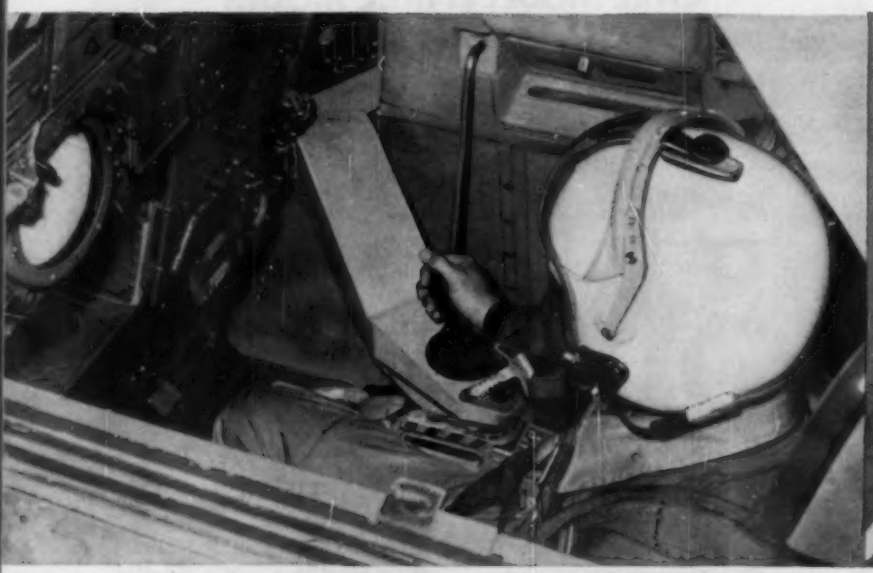
ADVANCED INERTIAL GUIDANCE

Complete systems or components for aircraft, missiles and spacecraft

To design and produce extremely accurate inertial guidance systems requires a complex combination of engineering and manufacturing skills. Each component must be developed to meet the accuracy needed for the system's mission.

The long background in gyroscopics, electronics and computation has made it possible for Sperry to design and produce advanced inertial systems for some of our country's most modern weapons of defense. Other Sperry inertial systems will, one day, allow man to explore space.

On these pages are highlighted some of Sperry's recent achievements in inertial guidance. If you have a systems problem or are interested in individual components, write our Air Armament Division for further information.



CONVAIR'S B-58 HUSTLER with Sperry inertial navigation system will be able to navigate undetected for thousands of miles to exact target. Most nearly automatic airplane yet developed and requiring only a 3-man crew, the B-58 will fly faster than sound at altitudes well over 50,000 feet.

HYPERSONIC, ROCKET-POWERED X-15 manned research aircraft by North American is designed to explore near space. Sperry inertial system, developed for USAF, will give pilot data for navigating and maneuvering the NACA-sponsored X-15 with extreme accuracy at speeds of one mile per second.

EXTERNAL stiffeners replace conventional wing ribs to cut production costs on new Davis DA-1 five-seat lightplane.

Davis 'Family Cruiser' Undergoes Tests

A new five-place "family cruiser" all-metal lightplane, designed to sell for under $10,000 in production, is being flight-tested by a small recently formed aircraft company in Lake Village, Ind.

Pre-production prototype of Davis DA-1 has been flown approximately 60 hr. Grossing 2,400 lb., it has broken ground in 235 ft. at 60 mph., climbed at 1,000 fpm. from hard surface runway; attained 1,000 ft. altitude in one minute climbing at 90 mph. from a grass surface when outside temperature was 85F, Leeon Davis, president of Davis Aircraft Corp., told AVIATION WEEK. Powerplant is a 180-hp. Lycoming 0360 turning a fixed pitch McCauley Met-L-Prop.

Type certification will await building of a production prototype, which Davis expects to start in a few months. He reports that flight tests thus far with pre-production prototype indicate that very few changes are necessary. These will primarily entail lightening structure; Davis' goal is to have airframe empty weight equal useful load of 1,200 lb. He noted that in first airplane he cautiously used heavier gage material than has been found necessary; wing skin for example is .025, which will be thinner in production type.

Design characteristics utilized to save weight and simplify structure, include:

• **Constant chord wing** is built around only three internal spars assembled from extrusions and plate. In place of ribs, there are 11 external chordwise pre-formed hat section extruded stiffeners, formed from heat-treated 24ST aluminum alloy. Each wing panel comprises less than 40 separate pieces, many of which are duplicates.

• **Vee-tail** is an all-flying configuration in which the two sections are operated differentially from the rudder pedals for turning, both sections working together to provide elevator action. Entire leading edge of the Vee-tail, which is angled upward at 100 deg., is also the spar to which a hollow tube mounted in bearings is fastened to provide pivoting. Under the tail is a small horizontal surface which serves as trim tab. System is interconnected to the tail by a bungee. Tail surfaces are also fitted with static balances, projecting from the tips.

Rectangular Fuselage

Fuselage is virtually rectangular in cross-section to provide maximum room. Seating is two in front, a single seat in rear for three. Baggage compartment is behind the rear seats and is designed to hold 53 lb. Cabin entrance and baggage doors are on right side of fuselage. Fuselage cross section narrows markedly behind the cabin.

Landing gear is fixed tricycle type with all wheels the same size. Landing gear struts are cantilever type utilizing tubular steel torsion bars.

Davis DA-1 spans 32 ft., is 22 ft. 3 in. long. Wing chord is 5 ft. 3 in. Wing area is 167 sq. ft., providing wing loading of 14.4 lb./sq. ft. and power loading of 13.3 lb./hp.

Fuel is stored in metal tanks, providing 42 gal. capacity. These comprise two 19 gal. tanks in the wings and two 2-gal. header tanks in the fuselage. Davis estimates that this fuel load provides a range of 475 mi. at maximum cruise speed. Maximum speed is calculated at 145 mph. and cruise at 127 mph.

He expects that the cleaned up pre-production prototype will cruise at over 130 mph. at 10,000 ft. at 70%-75% power at gross weight.

Davis' partner in the project is Vice President Harold Loy. Davis has been actively studying the light aircraft market for many years, decided upon a five-place configuration over a two-placer for his initial venture.

Initial marketing plans call for selling production versions directly through dealers, skipping a distributor-type organization.

Helicopter Pours Cement Foundations

Pouring foundations for a residential housing project is being done experimentally by a helicopter near Toronto, Canada.

Tru-Wall Concrete Forming, Ltd., is testing this method to overcome slack periods in the spring when rain makes roads in former farmland area impassable to heavy cement trucks.

A helicopter carries a bin slung from a cable under the fuselage, and a workman on the ground operates a release to permit cement to pour into foundation forms.

Three Sparrow III missiles are carried on belly of Chance Vought F8U-3. Ventral fins are lowered for high speed stability.

Missiles Recessed In F8U-3 Fuselage

Recesses in forward fuselage of Chance Vought F8U-3 Crusader III fighter are used to house three Sparrow III air-to-air missiles. Photo at lower right shows how the nose gear is offset to carry one Sparrow on the belly; other two are recessed on lower sides. One missile tail fin apparently retracts or folds against the side of the fuselage. All-weather jet fighter is an entry in U. S. Navy competition. The aircraft is powered by a Pratt & Whitney J75 turbojet engine producing 26,000 lb. thrust with afterburner. Fuselage utilizes a considerable amount of titanium on the after section. Ventral fins retract to near horizontal position for landing and ground operations.

Dark metal on Crusader III aft section is titanium.

Offset nose gear permits carrying one missile on plane's belly.

M-3 Arcweld Creep Rupture Tester, custom designed for labs which test smaller size specimens or use lighter loads.

For accurate creep rupture testing choose from 8 ARCWELD models

Wherever there's a need for accurate, economical creep rupture testing, the answer to that need is performance-proved creep rupture testers from Arcweld Manufacturing Co.

Choose from 8 compact, easy to operate, low maintenance Arcweld models. Capacity ranges from 6,000 to 30,000 pounds. Oversize Arcweld furnaces produce stable temperature up to 2,200 degrees maximum at no additional cost. Exclusive automatic beam leveling control: no matter how far the sample stretches, beam remains level.

Other products: eight-station rotary furnace jigs for hot tensile testing, master control panels, twelve-furnace Universal heat treat units and instrument cabinets.

Hundreds of thousands of hours of lab performance have proved Arcweld testing machines to be the *logical* choice. Clip this coupon or write on your business letterhead to Arcweld Manufacturing Co. today for more information and a complimentary Arcweld Creep Load Calculator.

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PRIVATE LINES

Market survey of applications of its 250-450-eshp. turbine powerplants to business aircraft is being made by Boeing Airplane Co.'s Industrial Products Division.

Aero Design & Engineering Corp.'s top level engineering thinking on company's future plans for turbine-powered business planes is that switch should be made from piston types directly to straight-jet powerplants, skipping turboprop phase, according to industry observers.

CAA is taking applications for examinations to fill vacancies for flight operations and airworthiness inspectors and airways flight inspectors with most of the posts being in the United States; some positions will be open in Washington, D. C., U. S. territories and possessions and foreign countries. Salary range is $5,985-$8,330 annually. Deadline for applications filed with Board of U.S. Civil Service Examiners, Civil Aeronautics Administration, Washington 25, D. C., is Nov. 20.

CAA warns buyers of military surplus helicopters and parts to be careful to procure complete and detailed records on the machines and parts critical from a fatigue life standpoint, since life-limited parts will not be considered airworthy unless suitable documentation is available to substantiate their history.

Research contract for some $200,000 covering drag reduction, stability improvement and other aerodynamic problems has been awarded by Air Force to Kellett Aircraft Corp., Willow Grove, Pa.

Lease for fixed base operation in new Sohio hangar, Cleveland-Hopkins Airport, Cleveland was signed by the petroleum firm and Aircraft Service, Inc. Hangar was constructed jointly by Sohio, United Air Lines and American Airlines; a secondary hangar is being built by Republic Steel Corp., Thompson Products and M. A. Hanna Co., for their corporate aircraft. Total cost of both structures will be some $4.2 million with Sohio's share being approximately $640,000. Aircraft Service will lease and operate the Sohio hangar.

Executive pilots two-year course designed to produce combination pilots-airframe and powerplant technicians will be inaugurated at Embry-Riddle Aeronautical Institute, Miami, Fla., Jan. 5, 1959, with additional courses starting in April and September.

NEW AVIATION PRODUCTS

Modular Packaging

Navy has contracted for development of re-usable aluminum modular packaging system for transport and storage of missiles and missile systems. Contract calls for four size-weight types giving environmental protection with minimum weight and cubage.

Zero Manufacturing Co., Burbank, Calif.

Aircraft Toilet

Electric-incinerating toilet, for use in both military and commercial aircraft, is designed to operate as a complete disposal plant. Designated Incinolet, the unit has a power input of from 1,200 to 2,500 watts. Device averages 18 lb. in weight for aircraft models and up to 40 lb. for ground installation.

Research Products Manufacturing Company, Dallas, Tex.

Oxygen Line Valve

Model OV601 oxygen line valve is designed for use on air transport and executive aircraft oxygen systems. The working parts, spindle and barrel assembly and Kel-F seat, are interchange-

able with OV601 oxygen cylinder valve. Valve is designed so that when operated at maximum rate there will be no instantaneous pressure surge downstream of the valve. Oxygen valve includes "O" ring spindle and barrel seals, Kel-F seat and positive action shutoff.

Robbins Aviation, Inc., 2350 E. 38th St., Los Angeles 58, Calif.

Aircraft Ground Test Set

Completely self-contained ground test set that monitors and measures aircraft power frequencies together with a.c. and d.c. power supply voltages contains no tubes or transistors and is free of external power supplies, according to the manufacturer.

Magnetic frequency sensing circuit provides an exact frequency indication from 350 to 450 cps. Separate meter scales indicate d.c. voltage from 0 to 40 v and a.c. voltages from 0 to 150 v and 0 to 300 v.

The Airpax Products Co., Seminole Division, Fort Lauderdale, Fla.

Aircraft Ski

"Airglide" ski has been designed for runs over rough, uneven snow surfaces. Tire of aircraft rests on upper surface

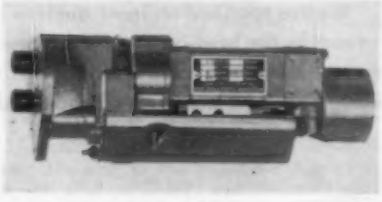
of ski board when ski is in "down" position. Ski is hydraulically controlled from cockpit so that operator can raise or lower skis while in flight or on ground, enabling him, it is claimed, to land or take off on either skis or wheels.

"Airglide" also can be purchased without hydraulic controls, has been tested in "bush country" of Canada, and has been approved by CAA.

Federal Ski and Engineering Corp., 3456 N. Mississippi Drive, Minneapolis 12, Minn.

Rotary Control Actuator

Double shaft output rotary actuator is designed for aircraft, missiles and ordnance equipment. Unit operates under a normal load of 8 inch pounds at 1,000 rpm. Use of a larger size motor



permits loads of 30 inch pounds at 200 rpm. Adjustable travel limit mechanism permits up to 250 turns of the output shafts. An adjustable electrical load sensing device automatically stops the unit in one direction and holds a predetermined load from 6 to 17 inch pounds.

Model D-1900 actuator includes a radio noise filter, integral thermal protector, an electro-mechanical clutch-brake for low overtravel and irreversibility. Dual counter rotating output shafts provide interchangeability of left and right hand units. Motors for 400-cycle operation single or poly phase and other d.c. voltages are available.

Hoover Electric Co, 2100 South Stoner Ave., Los Angeles 25, Calif.

Transistorized Power Supply

Fully transistorized, lightweight power supply provides closely regulated 28v d.c. and 260v d.c. with minimum size and maximum of reliability for 400 cps., the manufacturer states.

Developed for AN/ARN-14 Navigation Receiver, transistorized power supply weighs 4½ lb. and measures 7½ in. long, 3⅛ in. high and 4 in. wide, with ambient temperature of −55C to +55C, and intermittent operation to +71C.

Canoga Corporation, 5955 Sepulveda Blvd., Van Nuys, Calif.

Electra Engine Mount

Design of engine mountings to isolate vibration on Lockheed Electra turbo-

prop transport is compromise between soft mounting for reduced engine weight and stiff mounting for increased power, according to the manufacturer. Units were designed to withstand temperatures of −40F to 250F.

Three-point Dynafocal suspension system of bonded rubber mountings have no metal contacts. Two forward mountings (photo) carry vertical, lateral and longitudinal loads; rear mountings carry vertical loads and minimize lateral loads.

Total weight of three mountings is less than 25 lb.

System has built-in cooling arrangement, utilizing air scoop to feed ram air over the units.

Lord Manufacturing Co., 1635 W. 12th St., Erie 6, Pa.

CAB Accident Investigation Report:

High Closure Rate Caused Midair Crash

On April 21, 1958, about 0830, an Air Force F-100F and a United Air Lines DC-7 collided at 21,000 ft. over a position about nine miles southwest of the Las Vegas VOR station. The position was on Victor Airway 8 about 1¾ miles to the right (southeast) of the centerline. Both aircraft fell uncontrollable and crashed, killing the 42 passengers and five crew members of the DC-7 and the two Air Force pilots of the F-100F.

The accident occurred in clear weather conditions while the DC-7 flight from Los Angeles to New York was proceeding normally according to an IFR (Instrument Flight Rules) flight plan and clearance, and while the F-100F was executing a simulated jet penetration, part of an instrument training flight which originated at Nellis Air Force Base. The flight was according to a local VFR (Visual Flight Rules) flight plan.

The accident occurred in VFR conditions which, under the Civil Air Regulations, placed responsibility on the pilots of both aircraft to avoid collision through visual separation. This collision was the result of a high rate of near head-on closure at high altitude together with the human and cockpit limitations.

The accident occurred during an Air Force instrument training operation pursuant to Air Force policies which did not take adequate account of human limitations to avoid collision by visual means although the limitations were recognized in other training operations and were known to the Air Force.

The Civil Aeronautics Administration did not take sufficient measures to reduce known collision exposure in visual flight conditions.

Nellis AFB operational personnel, after the accident, took numerous steps which recognize the limitations of visual separation and which will reduce the collision exposure of the airway structure in the Las Vegas area.

The CAA has instigated a program of civil-military coordination, including the review of jet penetrations on a national scale. The goal in this undertaking is also to reduce collision exposure by segregating more effectively high-speed aircraft operations.

It has long been apparent that the possibility of collision increases markedly with very high closure rates of modern high-speed aircraft. Recognizing the limitations of the capability of visual separation by pilots under such circumstances, the Board has embarked on a regulatory program to require a positive control system to the extent that air traffic control facilities will permit. The initial step toward positive control at high altitude has been taken; however, because its implementation is governed by air traffic control capability, the ultimate goal as currently projected is several years away. In the meantime numerous other steps have been taken, or are under study, to ensure a reduction in collision exposure, and of course all parties operating high-speed aircraft must exercise the utmost caution during this interim period.

INVESTIGATION

On April 21, at 0737[1], N 6328C, a DC-7 owned by United Air Lines and operated as Flight 736, took off from runway 25L (left) of the Los Angeles International Airport. The flight was a scheduled passenger service from Los Angeles, Calif., to New York, N. Y., with intermediate stops at Denver, Colo.; Kansas City, Mo.; and Washington, D. C.

The departure was in accordance with an IFR flight plan which specified Victor Airway 16 to Ontario, Calif., and Victor Airway 8 to Denver. The flight plan also proposed a cruising altitude of 21,000 ft.,[2] a true air-speed of 305 kt., and a departure time of 0735. The flight plan remarked that a VFR climb to cruising altitude would be accepted.

The flight crew consisted of Capt. Duane M. Ward, First Officer Arlin E. Sommers, Flight Engineer Charles E. Woods, and Stewardesses Pauline M. Murray and Yvonne M. Peterson. Of the 42 passengers, five were nonrevenue.

Preparations for the flight were routine, and according to the company load manifest, the gross takeoff weight of the aircraft was 98,656 lb., well below the maximum allowable of 106,750. The load was computed to be within the center of gravity limitations.

Following takeoff, Flight 736 contacted the Los Angeles departure control on 121.1 mc. and was given radar vectors during the climb to clear weather conditions above a local haze condition which limited visibility to 2½ mi. Upon reaching the top of the haze layer the flight contacted the Los Angeles Center and received an IFR clearance which was "as filed." The flight was advised to climb in VFR weather conditions to 21,000 feet.

At 0753, Flight 736 reported to Aeronautical Radio, Inc., which serves under contract as the United company radio, that it was over Ontario, at 12,000 ft., and was climbing in VFR conditions. It estimated it would reach Daggett, Calif., at 0811. Thereafter, at 0811, Flight 736 reported over Daggett. In this report the trip stated it was then at 21,000 and estimated that it would reach Las Vegas (omni range station) at 0831. This was the last position report made by the flight.

At approximately 0745 that morning F-100F, 56-3755, took off from runway 4 at the Nellis Air Force Base, Las Vegas, Nev. The flight was an instrument training flight with Instructor Pilot Capt. T. N. Coryell occupying the front seat of the two-place aircraft and Trainee Pilot First Lt. J. D. Moran in the rear cockpit seat.

Preparation for the flight was routine. A preflight briefing was conducted by Captain Coryell during which the mission was reviewed. The flight was in accordance with a VFR local flight plan filed with Nellis Operations and the local traffic control tower. According to the flight plan it was proposed that the training mission would last 1 hr., 25 min., and that the fuel load was sufficient for about 1 hr., 50 min.

At approximately 0823 Air Force 755 called "Nellis VFR Control" and reported that it was "inbound on KRAM" (a local commercial radio broadcast station). The flight requested an altitude assignment from which it would conduct a simulated ADF instrument jet penetration utilizing KRAM. The VFR controller assigned 755, 28,000 ft. and advised it to report over the radio station. At approximately 0828, five minutes later, the flight reported that it was over KRAM requesting a penetration. The VFR controller cleared Air Force 755 for an immediate penetration and requested that it report the penetration turn. Air Force 755 then reported leaving 28,000 feet. There were no other reports from the flight in connection with this procedure.

Weather conditions in the Las Vegas area at the time of the accident were clear with visibility more than 35 mi. Winds at 21,000 ft. were from 300 deg. at 45 kt.

At 0830 the offices of Aeronautical Radio at Los Angeles, Denver, and Salt Lake City heard an emergency message from the United flight. The message was interpreted as "United 736, Mayday, midair collision, over Las Vegas." This message was recorded on equipment which permits a determination of the exact time of the message. By replaying the recording and timing it, it was learned that the message began at 0830 plus 20 sec.

At the same time, as nearly as can be determined, there was an unrecorded emergency transmission from the F-100F. This message was heard by the VFR controller and by the two pilots of another F-100F. All were agreed that the first portion of the emergency transmission was "Mayday, Mayday, this is 755." The last part of the message was either "We've had a flameout" or "We're bailing out." All of the persons who heard the transmission believed the message could have either interpretation. Since it was unrecorded no further determination can be made from this source.

A committee of investigators contacted 140 persons who were reported to have seen some portion of the accident. Of these persons, 49 gave statements describing their observations. A study of these statements indicated that only two youngsters, ages 13 and

[1]All times herein are Pacific standard and based on the 24-hour clock.
[2]Altitudes, unless otherwise indicated, are mean sea level.

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Temperatures made to order for all types of aircraft engines. Harrison heat exchangers are rugged, reliable and compact . . . engineered to provide the optimum in cooling efficiency.

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There's no heat problem on the Bell . . . 'cause Harrison's on the job, keeping oil temperatures under control. The Harrison engine oil cooler used on the Bell H-40 is the only cooler that met the requirements for minimum pressure drop, weight and compatability with synthetic oils. And these weight-saving, space-saving heat exchangers provide the optimum in heat transfer efficiency, too! That's why you'll find Harrison coolers specified on most modern helicopters. Harrison has over 47 years in the heat-control field to assure you of dependable, trouble-free service under the most severe operating conditions. So, if you have a cooling problem, look to Harrison for the answer.

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PRODUCT DESIGN • Design and packaging of electronic systems and sub-systems for high performance missile program.

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SYSTEMS DESIGN INTEGRATION • Coordinate system integration on navigational and guidance systems. Test prototype systems, analyze and evaluate same.

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SYSTEMS DESIGN • Analyze design requirements. Conduct design work on low frequency wide bank and pulse circuitry as applied to radar systems and computers.

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RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

8, saw the aircraft before they collided. Their observations, when compared with structural and operational evidence, proved quite accurate. Their observations indicated the aircraft approached each other quartering head-on, with the DC-7 flying northeasterly and the F-100F flying southerly or southeasterly. They indicated that a few seconds before impact, and while the DC-7 flew straight and level, the F-100F rolled in an obvious attempt to avoid the DC-7. The direction of roll was in dispute. At the instant of contact a third witness saw the aircraft and described them as nose-to-tail, on northerly and southerly headings, and with the F-100F banked steeply. The three witnesses said a wing of each aircraft made contact although they could not tell which. They stated there was a puff of smoke, a flash of fire, and a shower of metal pieces indicating the collision.

DC-7 Spirals Down

Following the collision numerous witnesses saw the DC-7 "stagger" straight ahead, then descend in a right turn which became a steep spiral or spin. After one or two turns the engines of the DC-7 tore out accompanied by a flash of fire.

It is believed several witnesses who saw this thought it was the collision. After several turns the aircraft struck the ground and exploded.

The F-100F was described as having proceeded on a southerly heading with white or gray smoke marking its arc to the ground. The F-100F fall was described as a very steep descent during which one or two witnesses thought that the aircraft rolled about the longitudinal axis.

Of the persons who noted both aircraft nearly all agreed the F-100F crashed much sooner than the DC-7 and that it also exploded on impact.

All of the witnesses stated that the weather conditions were clear with no clouds in the sky and that the visibility was very good.

From the locations of several heavier pieces of wreckage and inconsideration of wind drift during their descent, the probable position over which the collision occurred was determined as nine miles southwest of the Las Vegas VOR station (located on McCarran Airport). This position was on Victor Airway 8, about 1¼ mi. southeast of its centerline.

Wreckage Locations

The main portion of the DC-7 wreckage was located approximately 2.6 mi. northeast of the estimated collision position. Investigation revealed that the aircraft was in a relatively flat attitude at ground impact with a high sink velocity relative to its forward motion. On impact it broke into numerous pieces along a heading of 160 deg. The wide separation between the ground marks made by each powerplant confirmed observations of eyewitnesses who stated that they separated in flight. Similarly, the wide distribution of many major wreckage pieces showed that a general disintegration of the aircraft occurred before the ground impact. Examination of the pieces of structure provided clear evidence that the inflight breakup of the aircraft after collision resulted from airloads which exceeded the design strength of the structure. There was no indication of structural failure prior to the collision.

The F-100F main wreckage site was located 5.4 mi. south-southwest of the DC-7 site. The aircraft had contacted the ground on a northerly heading and, similar to the DC-7, it struck the ground in a relatively flat attitude with extremely high sink velocity as compared to forward motion. The impact, and fire which followed, caused major destruction of the structure. As near as could be determined from the evidence, at ground impact the landing gear and flaps were up and the speed brakes were closed.

There was no evidence to indicate structural failure of the F-100F prior to the inflight collision.

During the investigation every effort was expended to determine, independent of eyewitness information, if there had been a midair collision and, if so, the manner in which it occurred. In doing this, much of the wreckage was documented as to location and identification. Thereafter most of the structural wreckage was removed from the scene to a location on Nellis AFB where certain areas from both aircraft were reconstructed and minutely examined.

Most important to these objectives were the right outboard wing sections of both aircraft and the right horizontal tail of the F-100F. These components were widely separated from the main wreckage areas and bore clear evidence of inflight contact which separated the wing sections as a result of and at the time of the collision. Examination showed these components were the only major ones directly involved in the inflight contact sequence.

The DC-7 wing section was found 2.5 mi. southwest of the DC-7 main wreckage. The F-100F right wing section, a heavier piece somewhat less subject to wind drift, was found 1,200 ft. west of the DC-7 wing section and it was about 3.3 mi. northwest of the F-100F main wreckage.

DC-7 Wing Swaths

There were two swaths cut in the DC-7 wing section, one which severed the piece and one which penetrated to approximately the front spar on the upper wing surface and to approximately the center spar on the lower wing surface. The major swath penetrated the DC-7 wing at station 580 at the leading edge of the wing and progressed irregularly through the wing chordwise to the trailing edge of the aileron. The exit of the swath was wing station 635. Measured along the leading edge the section of DC-7 wing which was severed was about 12 ft. in length. The average angle of this major swath was approximately 34 deg. measured from a chordline through the right wing or 34 deg. to the longitudinal axis of the aircraft.

As shown by wing station locations the cut therefore extended diagonally outboard and aft from the leading edge, through the wing, to the trailing edge of the DC-7 right wing.

The major swath was 24 in. wide. The structure within this area was shattered into small pieces, many of which were not recovered.

However, those pieces which were found were located with wing sections and below the collision point.

Examination of the inboard and outboard edges of the major cut, especially in the area where lighter structural material is used in the DC-7 wing construction, showed clearly that the object which cut moved slightly downward relative to the DC-7 wing. It was also revealed that edges of the swath on the lower wing surface were almost precisely below the corresponding edges of the swath on the upper wing surface.

This showed clearly that the cutting plane which made the cut was nearly perpendicular to the DC-7 wing plan form.

Second Cut

The second cut in the DC-7 wing was located between stations 511 and 503. It was essentially parallel to the major swath and was about eight inches wide. As previously mentioned, this cut extended rearward to the front spar on the upper wing surface and to the center spar on the lower wing surface, indicating heavier structure was cutting the lower wing surface of the DC-7. The effect of the two swaths was to cut out a section of leading edge of the DC-7 wing about three feet in length between wing stations 509 and 543 at the leading edge and between wing stations 525 and 557 at the front spar. The relatively short depth of the second swath showed the cutting object was destroyed before it could cut through the entire wing. The upper wing skin behind the cut and in line with it or the area aft of the center spar at about station 528 was marked by a deep cut and related deep scratches running aft and outboard in line with scratches found on the aileron.

F-100F Wing Cuts

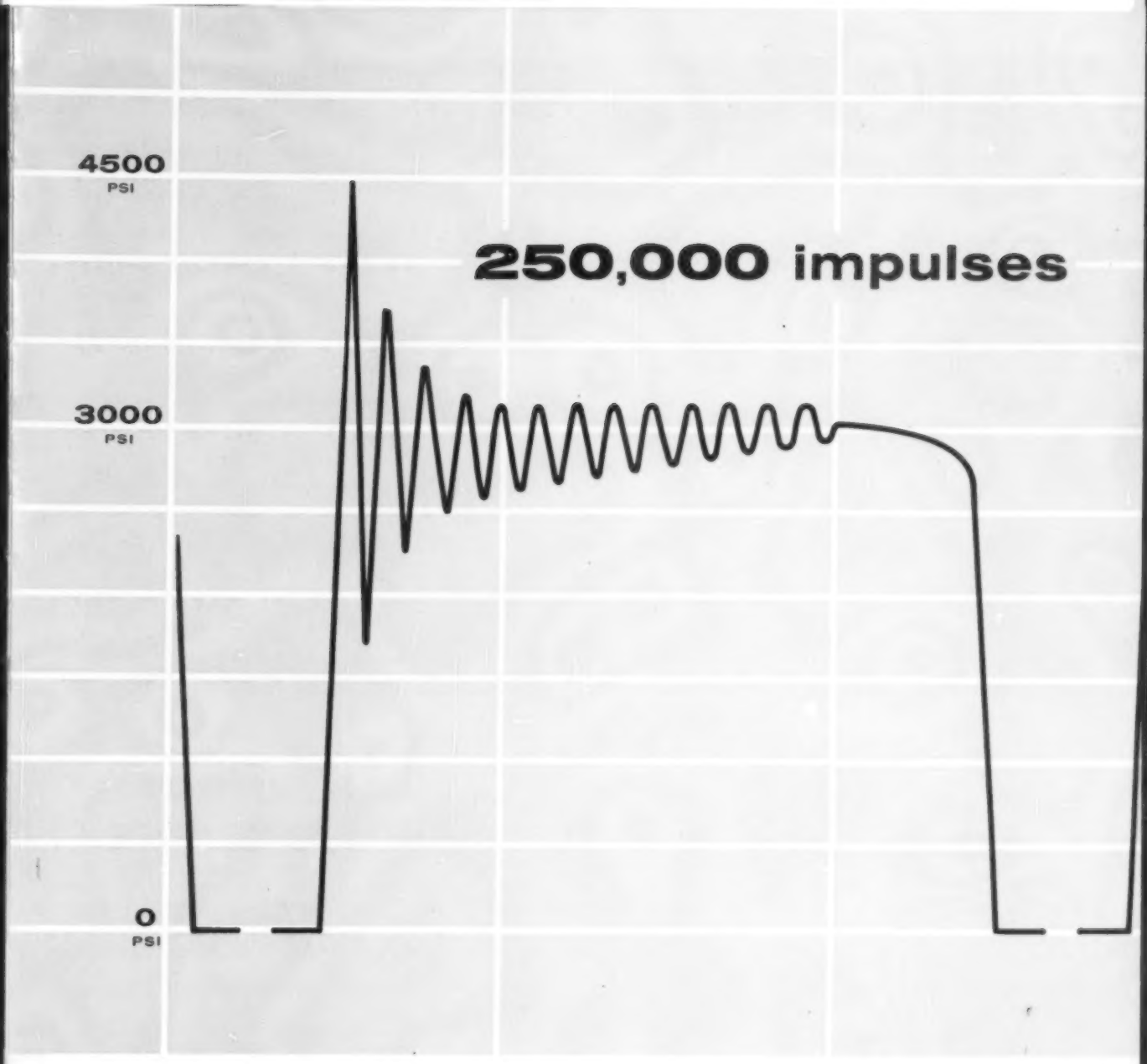
The wing section severed from the F-100F measured approximately 12 feet. The swath through this right wing was irregular; however, the average angle of the swath was 12 deg. relative to the longitudinal axis of the aircraft. The inboard edge of the cut was 132 in. from the fuselage centerline at the wing leading edge and was 86 in. from the fuselage centerline at the wing trailing edge.

Thus, the swath ran aft and inboard through the F-100F wing panel.

The width of this cut was about 16 in. The structure within this area was shattered, some of which was found below the collision location. One piece from this area was found loose inside the severed wing section of the DC-7.

The right horizontal tail of the F-100F was broken off 86 in. from the centerline of the aircraft. The outboard portion was not recovered. Investigation showed that a line drawn through the wing swath of the F-100F at the angle of 12 deg. previously shown passed through the horizontal tail at the fracture line. This clearly showed that the object which cut through the wing panel of the F-100F also contacted and tore off the severed portion of the right horizontal tail of the jet airplane.

The DC-7 powerplants were recovered about one-half mile northeast of the DC-7 wreckage. They were removed from the desert area to a suitable area for a more detailed examination. Each powerplant had been torn free from the DC-7 with most of the nacelle attached. Evidence indicated



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the nacelle structure failed from excess loads. However, there was insufficient evidence to indicate the manner in which failures occurred. Each powerplant struck the ground in a similar manner as evidenced by impact damage to each unit on the right side. The accessory case was broken from each powercase.

Engine Examination

The engines were partially disassembled to examine their interiors. This disclosed that remaining gear trains, bearings, and other moving parts had been normally lubricated. The articulating assemblies showed no evidence of operating distress and the examination of the oil pumps and screens showed they were free of foreign materials.

Several engine accessories were recovered. However, impact and fire damage precluded them from being functionally checked.

Each DC-7 propeller remained attached to its engine and each was found to be tight on its propeller shaft. Although impact damage made it impossible to obtain the propeller dome settings it was possible to determine readings of the propeller blade angles from impact marks on the shim plates. It was learned from this work that all of the propellers were operating at blade angles within the cruising range. This is considered a clear indication of normal inflight operation of the engines and propellers until the powerplants separated from the aircraft.

The jet engine, a Pratt & Whitney J-57-P-21A, was with the main wreckage of the F-100F but had torn free of the fuselage structure. It was badly damaged by ground impact, the attendant explosion, and subsequent ground fire. It was removed and transported to the Nellis AFB engine overhaul hangar where it was completely disassembled. Because of the conflicting interpretations of the final radio transmission from the aircraft, every effort was expended to determine if there had been an inflight malfunction or failure of the powerplant prior to impact which would have caused it to "flame out." Examination of the compressors, combustion section, turbines, and all bearings revealed no evidence of malfunction or failure prior to ground impact. In fact, from the clear rotational indications shown on the stator, compressor, and turbine blades highly experienced personnel estimated that the engine was operating in excess of 80% power at ground impact. From this evidence it was concluded that the final transmission from the crew must have been "We're bailing out" and that the flight had not experienced a "flameout."

No Radar Facilities

Nellis AFB is located about six miles northeast of Las Vegas. It is below Victor Airway 8 and within its lateral confines. At the time of the accident its principal mission was the training of recently graduated Air Force pilots as "combat ready" in the F-100 aircraft, a supersonic fighter. Actual instrument approaches to Nellis are controlled by McCarran approach control and there are no radar facilities such as RAPCON (Radar Approach Control) or GCA (Ground Controlled Approach) that serve the Base.

The flight curriculum followed is established by Air Force and Air Training Command regulations and consists of about 35 flight hours, supplemented by intensive associated ground training. The flight curriculum includes air combat maneuvering, formation, gunnery, and instrument phases.

Flying training at the Base was conducted in VFR weather conditions only and, at the time of the accident, in accordance with local VFR flight plans. Normal activity at the Base on a training day was between 500 and 800 aircraft movements (takeoffs and landings), of which about 400 were attributable to the training function.

Individual missions were flown within a local flying area, roughly 125 mi. square, and principally that area north, east, and west of the Base.

The local flying area was established in accordance with Air Force Regulation 55-19 and is a common requirement for all Air Force Bases.

Generally, the trainee pilots were Second Lieutenants with about 330 to 360 flying hours. They were jet qualified and held instrument ratings issued by the Air Force.

The flight phases are supervised by instructor pilots at squadron level. These pilots are highly qualified personnel selected according to Air Force directives and then trained for the work. Through an impressively rigid standardization program at all echelons the instructors are supervised and the training program is standardized. Instructor pilots supervise all training missions and, with the exception of three "solo tran-

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sition flights," accompany and lead the flights.

As indicated, instrument training is one of the phases of the curriculum. Normally it is accomplished after the trainee has about 15 hr. in the F-100 and has become familiar with the aircraft. This phase is designed to teach the student instrument flying in this particular aircraft since he is already instrument qualified in jet aircraft and holds an instrument rating issued by the Air Force. Instrument missions are flown in the F-100F, which is the two-place version of the F-100. It was stated that during this training the instructor pilot occupies the front cockpit and is responsible for the safety of the flight including the separation from other flights in visual conditions as required in the existing Civil Air Regulations. The student pilot occupies the rear cockpit seat and while the training is being conducted is precluded from outside vision by a hood designed to pull over the entire rear cockpit along the canopy above the student pilot's head.

The vision of the instructor pilot is not obstructed by the hood.

At the time of the accident the flying phases, excepting part of the instrument work, were done off airways in subdivisions of the local flying area. Careful consideration was given in this regard and many precautions were taken to keep the flights off airways or when crossing airways to maintain straight and level flight. Basic instrument flying was kept within the transition and formation subdivisions.

At the time of the accident that portion of instrument flying which involved the use of navigational aids such as holding, tracking, and jet penetrations, was practiced within a designated area with a radius of 25 mi. centered on Nellis AFB. This area included the intersection of several airways in the Las Vegas terminal area and it was mostly within the confines of the airway structure. Within this area all jet penetrations were practiced.

Air Force Regulation 55-19 governing the control of simulated instrument approaches states in part, "The commander will direct maximum use of outlying facilities in order to relieve air traffic congestion near local navigational facilities." The regulation also states, "Air Force Air Traffic Control Personnel who are not authorized to provide IFR control service will furnish traffic information to those pilots practicing instrument approaches and advise them to maintain VFR flight."

It was stated, with respect to AFR 55-19 and its provision to establish penetration on outlying facilities to relieve air traffic congestion near local facilities, that within the range capabilites of the F-100 there were no facilities suitable for the penetration other than those at Las Vegas. Also, it was most desirable to establish the penetrations near the base because they are performed at the end of a training flight when fuel is limited and the latter portion of the penetration is at low altitude when fuel consumption is highest. For these reasons, as well as the installation and maintenance costs, the establishment of outlying facilities was considered undesirable.

Nellis instrument training procedures required that before a flight entered the 25-mi. instrument practice area the pilot

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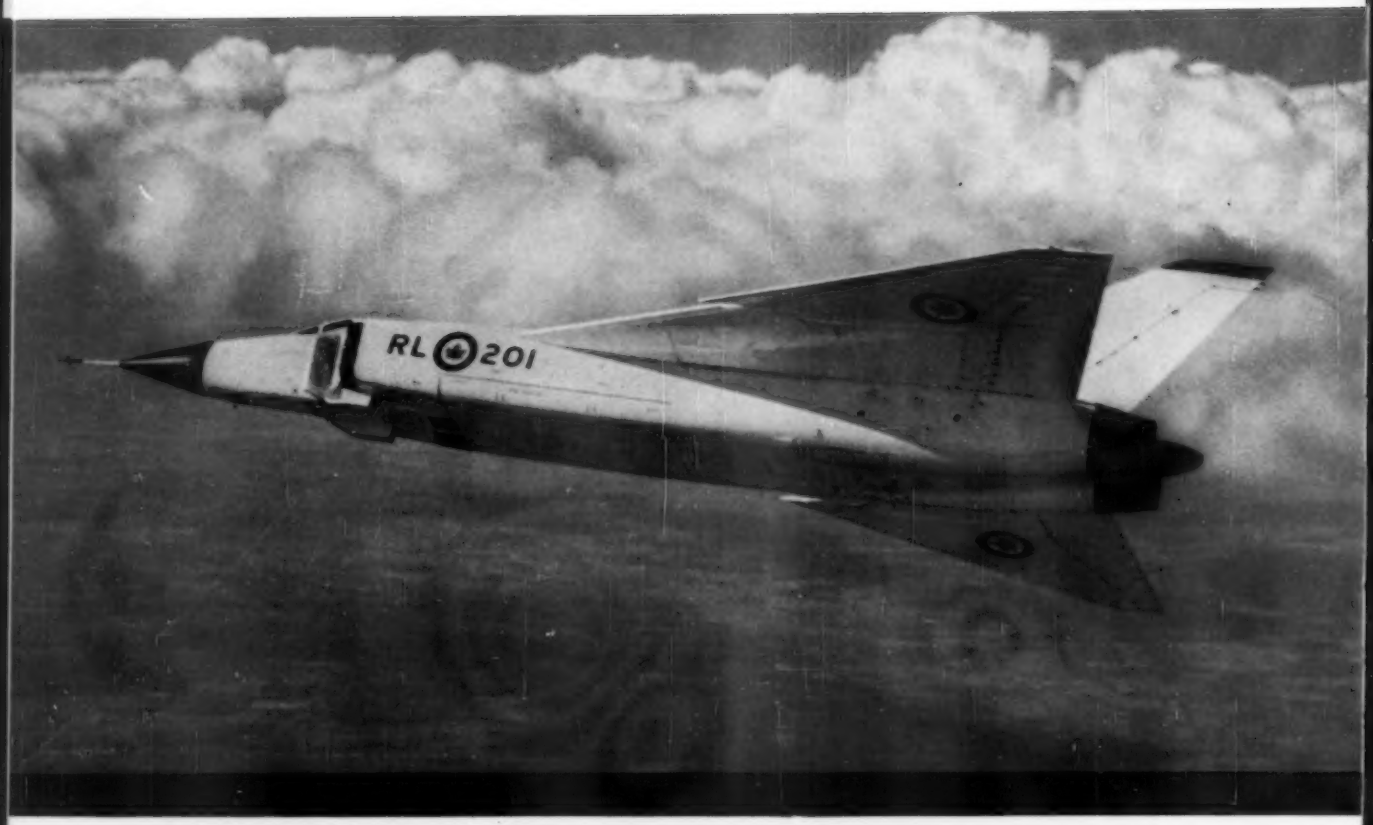

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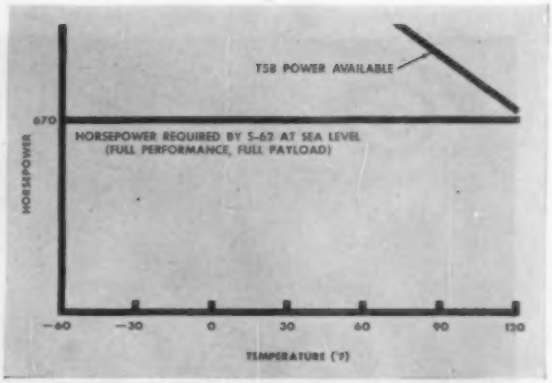

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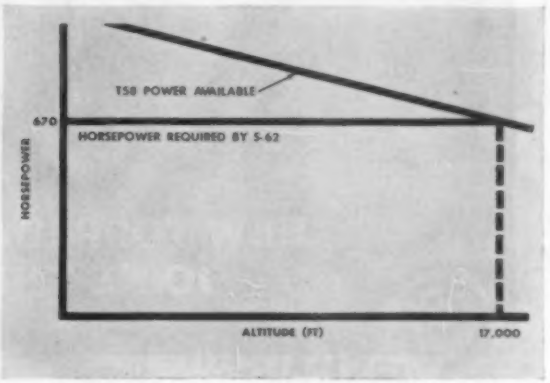

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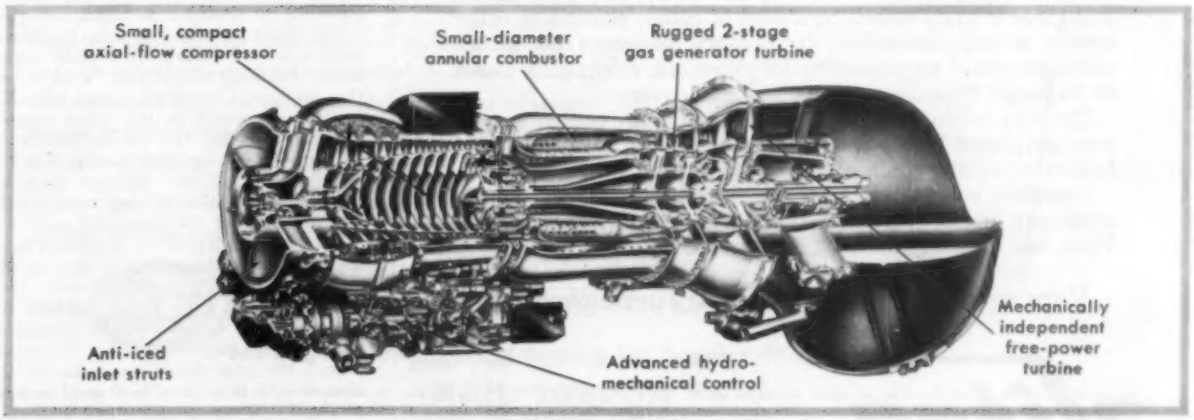

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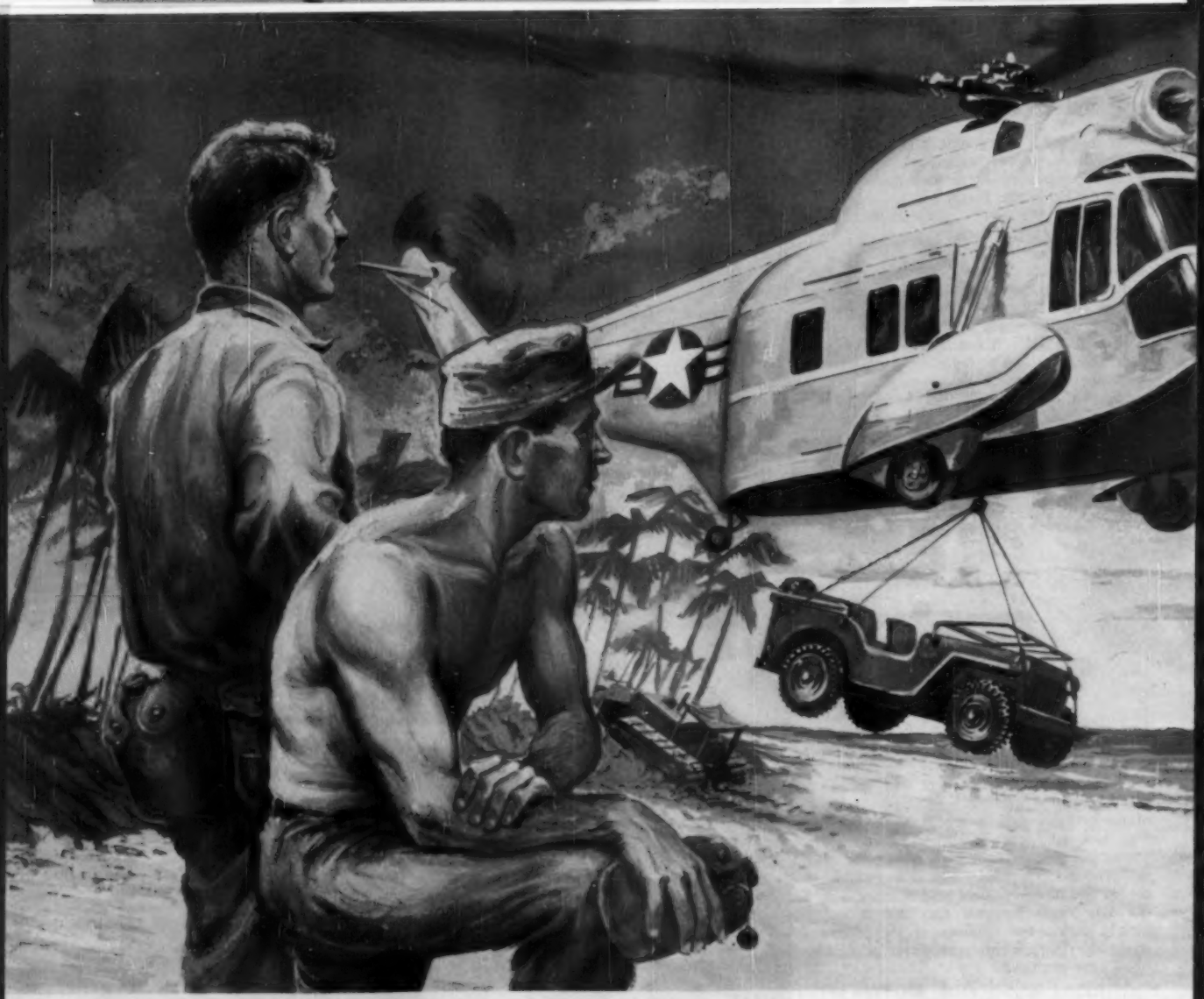

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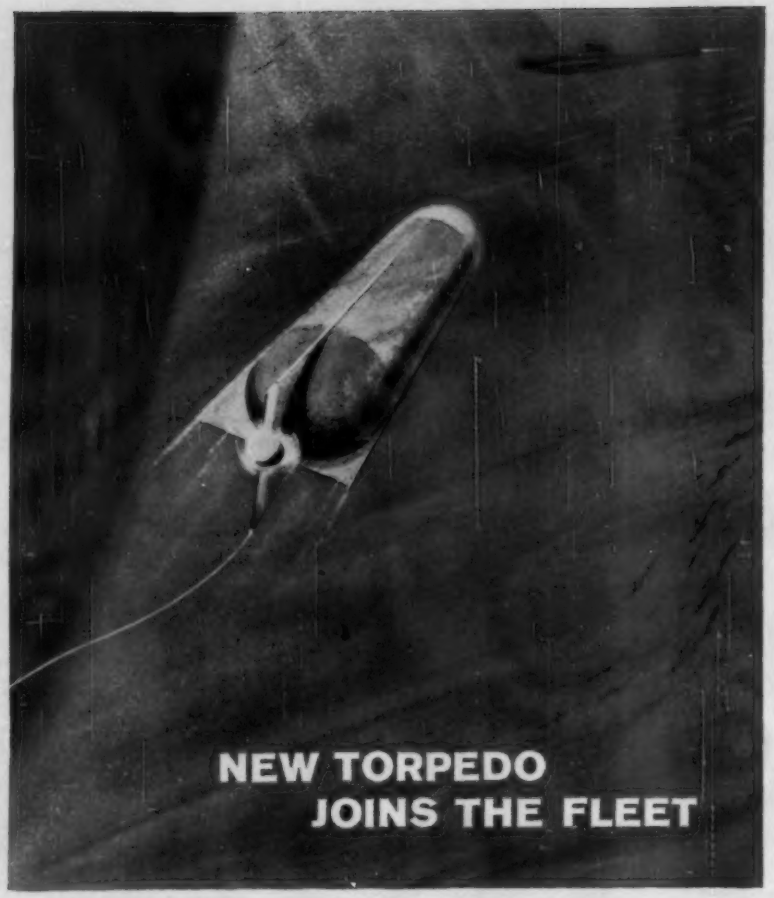

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must secure a clearance and altitude assignment. This was accomplished through "Nellis VFR Control" which simulates an approach control. VFR control was incorporated to relieve the workload of the control tower, to provide separation between Nellis aircraft, and to give the trainee pilots practice in radio procedures. The VFR controller normally gave altitude assignments, 19,000 ft. or higher, with 1,000 ft. vertical separation.

Testimony of Air Force personnel stated that the VFR control did not perform an air traffic control function except for Nellis aircraft and its use did not relieve the instructor pilot of visual separation responsibilities required of all pilots by Part 60 of the Civil Air Regulations, restated in Air Force Regulation 60-16 in equal or stricter requirements. It was stated that the VFR controller did not have knowledge of any air traffic other than the Nellis instrument training flights described. There were no procedures to alert the jets of other traffic known to Air Traffic Control. It was stated that such advisory service was beyond the capability of the Base and ATC facilities.

Penetration Procedures

Investigation revealed that at the time of the accident seven jet penetrations were used for the Nellis AFB. Three were published in the USAF Pilot's Handbook and the other four were unpublished procedures. Although all seven procedures were formulated according to standard criteria for instrument approaches the latter four were approved through a local letter of agreement dated May 10, 1957, entered into between the Base and the Civil Aeronautics Administration. The KRAM penetration was one of the unpublished procedures and, as shown, was being flown when the collision occurred. A review of the specified penetration track showed that it was nearly all within the lateral limits of Victor Airway 8. It was estimated by Air Force personnel that this procedure and the others were flown by all aircraft, training or otherwise, 40-60 times daily.

For the KRAM penetration procedure, according to qualified witnesses, the pilot would obtain permission to enter the instrument area and receive an altitude assignment. The flight should then "track in" on the commercial broadcast station. This inbound track would be one which requires less than a 45-deg. turn to the penetration heading of 170 deg. after passing over the radio facility. If the inbound track required a greater than 45-deg. turn, a right turn to intercept the outbound track was necessary. According to the established training procedures the speed of the aircraft should be 300 kt. indicated airspeed. After overheading the radio station approval for the penetration is obtained with permission to leave the assigned altitude. When approved, the pilot should report leaving the altitude. At this time the "speed brakes" of the F-100 are extended and a descent is established holding 300 kt. indicated airspeed. If necessary and when the ADF indications are stable, the pilot is expected to correct to a 170-deg. outbound track from KRAM. Normally the descent is continued until one-half of the initial altitude plus 3,000 ft. has been reached, in this instance 17,000 ft. At this altitude a right

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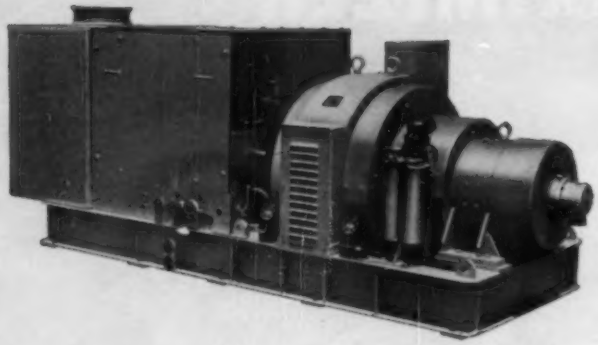

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penetration turn is required to a heading of 35 deg. The descent is continued throughout the turn and until a minimum altitude is reached on the 35-deg. heading. The aircraft is again turned, if necessary, to establish a 35-deg. inbound track to the runways at Nellis AFB. At the proper time, and if remaining fuel permits, the penetration is followed by a simulated missed-approach procedure and/or another penetration.

Approach Testimony

The Assistant Director of Air Traffic Control of the Civil Aeronautics Administration testified, in essence, that the penetrations were established according to the U. S. Manual of Criteria for Standard Instrument Approach Procedures, pursuant to Civil Air Regulations Part 60 (60.46). He stated that the principal considerations required were to establish a procedure which would be expeditious and safe as an instrument approach in instrument weather conditions. He stated that the agreement of May 10 was considered in this light and, because Air Traffic Control separates air traffic in instrument weather conditions, publication and dissemination of the procedures was confined to those controlling and performing the procedures. The agreement was therefore coordinated with the Salt Lake Control Center, McCarran, Tower, and Nellis AFB personnel. Certain divisions of the CAA received copies of the agreement for review or comment but these functions did not contemplate dissemination to other users of the airspace.

The Assistant Director testified that it was known to CAA that the procedures would be used extensively during VFR weather conditions for practice purposes. On such occasions, he stated, the penetrations were VFR procedures and rules governing visual separation applied. In this light dissemination of the agreement was unnecessary and would be of little value. In essence, he stated that prior to the accident extensive use of the jet penetrations in VFR weather conditions by high performance fighters was not a principal factor for consideration in formulating and/or approving such procedures. He stated also that the CAA was well aware that there were limitations to visual separation resulting from high speed and that the jet penetrations involved flight on airways where much of the air traffic, especially air carrier, was operating.

With respect to the use of advisory service which would alert known (IFR) traffic to instrument flights in the Nellis instrument area, the Assistant Director indicated that for such information to be of value it must be detailed, timely, and accurate when given. The witness indicated that such service was equivalent to IFR control. He said that this type of service had been studied and attempted; however, it so deteriorated normal IFR service the project was discontinued.

The Wing Operations Officer for the Nellis Training Wing stated, in response to questions at the public hearing, that he knew of no NOTAM which announced to other users of the airspace that extensive training was being conducted in the Las Vegas area. He stated, however, that on May 27, 1957, the Base had made application for certain off-airway areas within the Nellis local flying area to be designated "Caution Areas." This application, to his best knowledge, was, at the time of the hearing, on a "hold status" before the Washington Airspace Panel. Investigation has since revealed that the application was considered by the Airspace Panel on October 22, 1957, and was deferred at the request of CAA until CAA could review the general policy relating to the present definition of "caution area" and the compatibility of such areas with the Continental Control Area (above 24,000 ft.) and high altitude jet routes. Pending formal disposition, on June 10, 1958, all proposed caution areas were published in the Airman's Guide as "Military Training Areas" for the information of all concerned.

The witness further added that he personally had given a talk before the Aviation Committee of the Las Vegas Chamber of Commerce concerning the Nellis AFB training function and had distributed photographs showing the Nellis local flying area. (Minutes of the meeting showed a United Air Lines agent in attendance.) The minutes revealed that he informed the committee there would be 250-300 aircraft flying from the Base each day. The Operations Officer also said at the meeting that there was a need for the caution areas because speeds of the training planes made collision avoidance by visual means very difficult. At the public hearing the witness stated that he did not recall specific mention of the instrument area or the penetration procedures but that a photograph was distributed during his talk which showed the instrument area as it was located at the time of the accident. It was also noted that there was a caution area (C-436) located northwest of the Base, published on aeronautical charts. Legend indicated "Heavy aerial traffic" effective "Unlimited" and time "Continuous." The witness pointed out that the base had been ready and willing to furnish reasonable information concerning the training activity but to his knowledge none had been sought.

Necessary Facilities

With reference to the accident the Wing Operations Officer said that jet penetrations were flown on the airway structure because the facilities necessary in executing them were there. He felt, for the reasons already stated, it was impractical to perform them elsewhere or establish the aids elsewhere for practice purposes. He said that civil airways are open to all users and in his mind penetrations were not unusual or hazardous. He felt the F-100F flight was in compliance with Civil Air Regulations in all respects.

On the recommandation of the Air Force, an Air Force officer, who was an expert in the field of aerophysics, testified concerning the effectiveness of visual separation by pilots. Based on the circumstances surrounding this accident, he calculated the probabilities of visual detection by the pilot (s) of these airplanes over various ranges.

His conclusions substantiated the testimony presented by the Board's staff that the probability of collision increases markedly with the high closure rates of modern high speed aircraft. The witness's calculations were based on theoretical concepts developed some years ago by the Department of the Navy. He indicated that, although the results of his work in regard to this accident were not known to the Air Force, similar studies and results were well known.

The manager of United Air Lines flight operations stated that United pilots are instructed to plan their flights on airways, including the 1500 series, and on authorized high-altitude off-airways routes. Below 18,000 ft. and in controlled airspace the pilots are permitted to plan a flight and file it according to a VFR or an IFR flight plan unless weather conditions permit only an IFR flight. Above 18,000 ft. the flight must be planned and flown according to an IFR flight plan although VFR restrictions may be requested during climb and/or descent and when necessary. A flight over a high-altitude off-airways route must adhere to visual flight rules and only an IFR flight plan may be filed.

Flight Planning

The witness said that the planning and operating of a flight above 18,000 ft. according to IFR regardless of weather was to obtain as much air traffic control separation as possible. The witness stated that United understood that Civil Air Regulations and Air Traffic Control procedures did not preclude VFR flights in controlled airspace and during VFR weather conditions VFR and IFR flights would be intermixed. He said it was clear that in VFR weather an IFR flight received separation only from other like flights. Because of this, he said, it was United policy to require continued pilot vigilance for other traffic in VFR weather and, according to Civil Air Regulations, it was the pilot's responsibility to maintain visual separation regardless of flight plan or clearance. The witness furnished United company material and operation procedures reflecting this policy and said that cockpit vigilance was a subject of continuing emphasis.

The flight operations manager stated that certainly the location of Nellis AFB was known to United Air Lines personnel. He stated that operations personnel also knew it was a training base from which "Century Series" fighters were being operated. He indicated that this was all too well known from "near miss" incidents on the airways in the Las Vegas area which had occurred for more than a year. He did not know the number of such incidents but stated they were "numerous." The witness said that these incidents had been reported to the CAA both by telephone and correspondence. The witness stated it was his understanding that Nellis and CAA personnel had discussions about the incidents but he felt no corrective action resulted although he did not know.

Near-Miss Responsibility

The witness said that United Air Lines personnel had not gone to Nellis seeking consultation on the matter. He said that in the mind of United, the responsibility for the administration of the Civil Air Regulations belonged to the CAA. Consequently, all communications regarding the occurrences, which he believed were violations of the Air Traffic Rules, were directed to the CAA for appropriate action.

In regard to the jet penetrations, the flight manager stated the company did not have knowledge of them. He said United had not been furnished information on the

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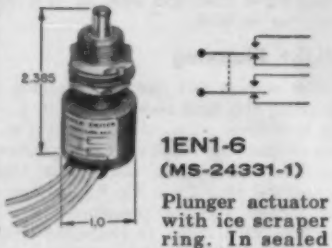
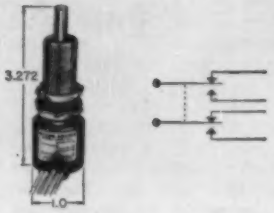


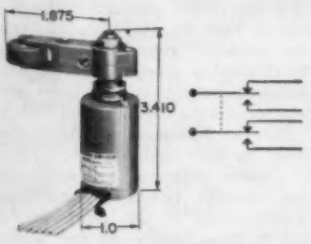
1EN1-6
(MS-24331-1)

Plunger actuator with ice scraper ring. In sealed enclosure are two SPDT subminiature basic switches. Operating force 6-12 lbs.; release force 4 lbs.; overtravel—.250 in. Rating: 28vdc 24a. inrush; 4a. resistive; 3a. inductive. Weight—2.5 oz.



1EN61-6

The longer bushing provides maximum adjustment range of operating point. Overtravel—.500 in. DPDT circuitry and capacity same as 1EN1-6.

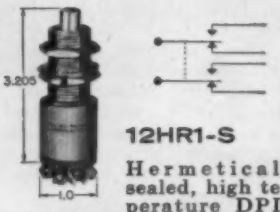


31EN1-6

Adjustable spring-return rotary actuator. Contains two "SM" switches (See 1EN1-6). Operating torque 30 in. lbs.; release torque 9 in. lbs.; total travel 45°.

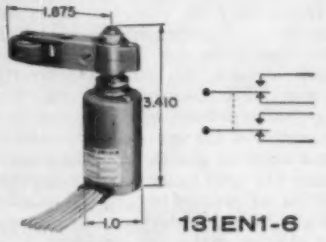
2EN1-6
(MS-24331-2)

This DPDT assembly contains two SPDT high capacity "V3" type switches. Rating: 28vdc—36a. inrush; 10 a. resistive; 6a. inductive. Operating force—6 to 12 lbs.; release force—5 lbs.; overtravel—.250 in. Weight 5.5 oz.



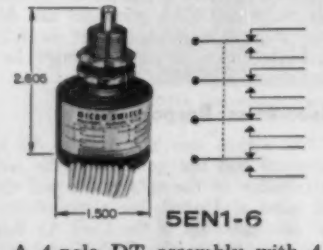
12HR1-S

Hermetically sealed, high temperature DPDT switch for reliable use to 600° F. Metal-to-metal & glass-to-metal seals in accordance with Par. 5.2.2, MIL-E-5272A. Ice scraper ring on actuator. Rating 28vdc-5a. res.; 2a. ind. Operating force 6-12 lbs.; release force 5lbs.; overtravel—.250in. Weight 4.5 oz.



131EN1-6

Special high temperature construction for up to 250° F. Adjustable spring return rotary actuator. DPDT. For rating see 1EN1-6. Operating force 30 in. lbs.; total travel 45°; differential travel 6°. Weight 2.65 oz.

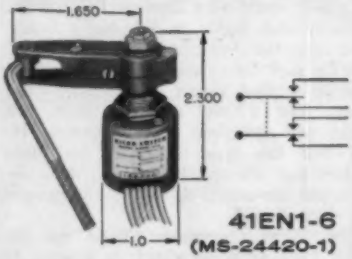


5EN1-6

A 4-pole DT assembly with 4 SPDT "SM" basic switches sealed in enclosure only 1½" dia. Mechanical characteristics same as 1EN1-6 except differential travel. 28vdc—24a. inrush; 4a. resistive; 3a. inductive. Weight 4.25 oz.

4EN1-6
(MS-24331-4)

Sealed within the 1½" dia. enclosure is one 4-circuit double-break "TB" series switch. Rating 28vdc—30a. inrush; 15a. resistive; 10a. inductive. Operating force—6-12 lbs.; release force—5 lbs.; overtravel—.250 in.



41EN1-6
(MS-24420-1)

Has rotary actuator with linkage for positive drive and release. Lever arm adjustable through 360°. Two SPDT "SM" switches in sealed enclosure provide DPDT circuitry. Operating torque—3 in. lb.

Switches have uses unlimited

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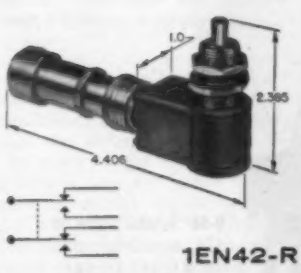
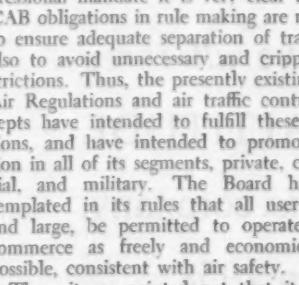
44EN1-6
(MS-24420-4)

Rotary actuator arm adjustable through 360°. Contains one 4-circuit basic switch. Rating 28 vdc—30a. inrush; 15a. resistive; 10a. inductive. Operating torque —10 in. lbs.



1EN42-R

A special design for high shock applications. Contains two SPDT switches. See 1EN1-6. Quick disconnect connector.



1LS1

Versatile, sealed indicator and limit switch for launching equipment. Head adjusts to 4 positions; arm adjusts through 360°; operation adjusts to either or both directions. Two-circuit basic switch. Rating: 10a. 120, 240, 480vac. Operating force 3 lbs.; release force ½ lb.; overtravel 30°.

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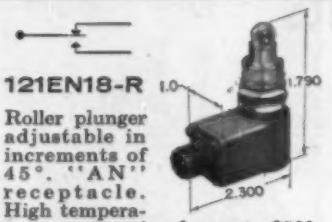
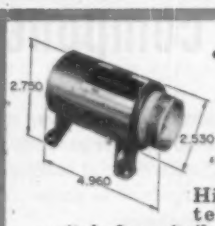


121EN18-R

Roller plunger adjustable in increments of 45°. "AN" receptacle. High temperature construction for up to 250° F. Contains two gold-contact "SM" switches. Characteristics same as 1EN1-6.



1RS1
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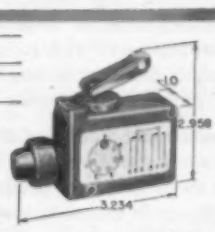
4CE1

Rugged indicator or limit switch for missile shelter, erecting and launching equipment. SPDT. Rating: 10a. 125vac; 5a. 250vac. Operating force 6-10 lbs.



3EP2-E

Sealed, sidemount enclosure contains two SPDT high capacity switches. Sealed receptacle. Rating: 28vdc-36a. inrush; 10a. res.; 6a. ind. Operating force 4-6 lbs.; release, 2 lbs.

penetrations, resulting from the Nellis CAA agreement, although he believed such information was most desirable and should have been given other users of the airspace. He indicated that while it may have been reasonable to expect that approach procedures would be flown during the Base training program he did not know penetrations such as KRAM were being flown. The operations manager said that he did not think it was reasonable to expect that high speed jet penetrations were being flown under uncontrolled conditions, as far as Air Traffic Control was concerned, in the center of a highly traveled airway such as Victor 8. The witness said that had United been informed of the penetrations he thought the company would have taken steps to alleviate the condition. The witness also added, in response to questions, that United personnel had not asked Nellis personnel for information concerning the operation or the extent of it from the Base.

The United representative, who was in attendance during the Chamber of Commerce meeting when the Nellis Wing Operations Officer spoke, stated that he had received a copy of the photograph distributed. This, he said, was forwarded to the office of the United operations manager in Los Angeles. The operations manager did not recall receiving the photograph and had no knowledge of its disposition.

Witnesses from the Board's regulatory staff testified that under the Civil Aeronautics Act of 1938, as amended, the Board is charged with the responsibility of prescribing rules for the regulation of air traffic. In Title I, Section 2, of the Act, the Congressional intent is set forth by which the Board is guided in this responsibility. It requires, "The regulation of air commerce in such manner as to best promote its development and safety"; and, "The encouragement and development of civil aeronautics." The Act also states that full consideration shall be given to the requirements of national defense. It states further that "There is hereby recognized and declared to exist in behalf of any citizen of the United States a public right of freedom of transit in air commerce through the navigable air space of the United States."

Air Freedom

It was further stated that from its Congressional mandate it is very clear that the CAB obligations in rule making are not only to ensure adequate separation of traffic but also to avoid unnecessary and crippling restrictions. Thus, the presently existing Civil Air Regulations and air traffic control concepts have intended to fulfill these obligations, and have intended to promote aviation in all of its segments, private, commercial, and military. The Board has contemplated in its rules that all users, small and large, be permitted to operate in air commerce as freely and economically as possible, consistent with air safety.

The witness pointed out that it is true that in some instances the freedom from crippling restrictions and the free and expeditious flow of traffic by all users may conflict. The Board has therefore sought to develop rules which best serve the public interest. It is equally evident that Air Traffic Rules must consider the capacity of the existing air traffic control system which is a responsibility of the Civil Aeronautics Administration.

The exsting Air Traffic Rules and control concepts, it was stated, classify all air traffic into two broad categories, Visual Flight Rules and Instrument Flight Rules. In the first category it is assumed that pilots are able to see and avoid other traffic, and in the latter it is assumed that weather conditions preclude them from carrying out this responsibility. Civil Air Regulations clearly define the weather conditions which permit or require VFR and IFR operations.

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vide additional safeguards to ensure that other users are not endangered.

Personnel of the Board's staff testified that the Board was well aware of the fact that visual flight rules are not a complete guarantee against midair collisions. In fact, in the last 10 years there has been a total of 159 midair collisions involving civil aircraft, almost all of which occurred in VFR weather conditions. It has long been apparent, moreover, that probability of collision increases markedly with the very high closure rates of modern high speed aircraft such as the "Century Series" jet fighters and that, at the highest of such speeds, margin for collision avoidance by visual means is nonexistent.

However, determination of the particular closure rate at which pilot capability to see and avoid other aircraft has disappeared or is reduced to an intolerable level is a judgment concerning which considerable difference exists. This is a problem which is now undergoing intensive investigation and study by the Board in an effort to reach more definite conclusions. Meanwhile, the Board has determined that the Civil Air Regulations should continue to make provision for visual flight operations with whatever refinements are practicable to reduce exposure to collision.

Wide Distribution

The Civil Air Regulations are given wide distribution among all who fly and knowledge concerning their contents is required as a condition of airman certification. Moreover, the Board's rule-making processes ensure that all interested persons are given full opportunity to participate in the making of regulations. All major segments of aviation do in fact participate by personal representation or in writing. The visual flight rules have been developed and maintained through such processes. All major segments of aviation have been in agreement, and to the Board's knowledge, are still in agreement, that the limited capabilities of the air traffic control system prevent a complete alternative at this time.

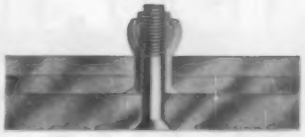
Personnel of the Board's regulatory staff testified that the responsibility for the approval of instrument approach procedures was delegated to the Administrator in Civil Air Regulation Part 60 (60.46). Testimony indicated that because this regulation is part of the instrument rules it was not required to consider VFR use of the procedure as a factor in the approval. In essence, it was stated that sufficiency of the procedure for use under IFR was the only required consideration.

The three principal areas of collision damage and related marking furnished the foundation for the Board to make a reasonable determination of the inflight collision sequence. This, together with operational and eyewitness information, also enabled reasonable deductions as to the flight paths of the aircraft as they approached point of collision.

The analysis indicated that initial contact occurred between the leading edge of the DC-7 right wing at station 574 and the leading edge of the F-100F right wing 132 in. outboard of the aircraft centerline. The two wings progressively penetrated one another until the outboard portion of each was severed; in the case of the DC-7 the

Blind Nut FIX

KEEPS AN F-104 ON SCHEDULE



Two damaged nutplates attaching the main landing gear door hinge to the fuselage threatened to keep a completed F-104 from entering final inspection. A conventional repair would have required the removal of a structural air duct to gain access into the closed-out area to replace the nutplates.

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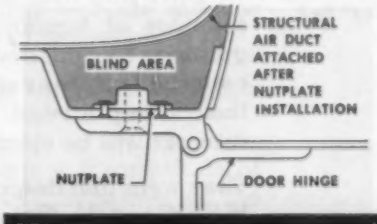

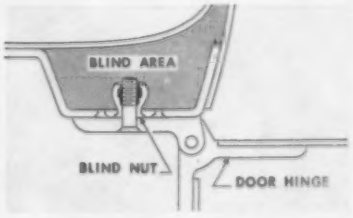

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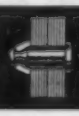

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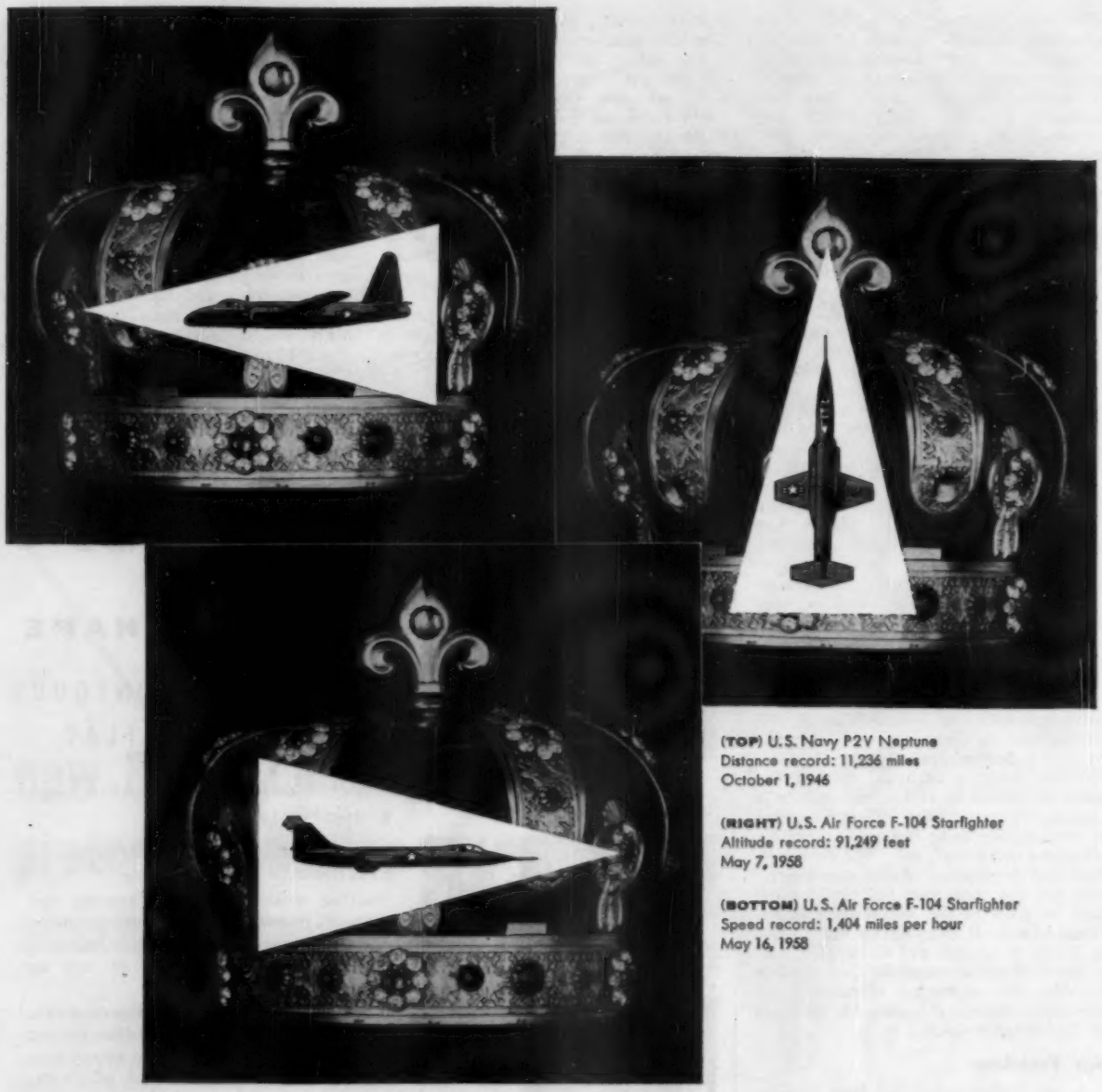

(TOP) U.S. Navy P2V Neptune
Distance record: 11,236 miles
October 1, 1946

(RIGHT) U.S. Air Force F-104 Starfighter
Altitude record: 91,249 feet
May 7, 1958

(BOTTOM) U.S. Air Force F-104 Starfighter
Speed record: 1,404 miles per hour
May 16, 1958

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wing was severed along a swath line 34 deg. aft and outboard, and in the instance of the F-100F along a swath line 12 deg. aft and inboard. A second cut in the DC-7 wing, located about 24 in. inboard of the first, was made by the right horizontal tail of the F-100F which penetrated rearward until the cutting object, the outboard portion of the tail, was destroyed. This entire collision sequence occurred in less than 1/100 of a second.

A vector diagram, using the 34-deg fracture line in the DC-7 wing, estimated true airspeeds of the DC-7 and F-100F of 312 and 444 kt., respectively, and assuming a small angle of descent for the F-100F, indicated that at impact the aircraft were on quartering head-on courses about 122 deg. apart with a closure speed of about 665 kt. Believing the DC-7 was flying a magnetic heading to follow Victor Airway 8 and was in nearly straight and level flight, at collision the heading of the DC-7 was 23 deg. magnetic and the heading of the F-100F was 145 deg. magnetic.

Fighter Position

This heading for the F-100F seems reasonable because the aircraft was to the right of the desired 170-deg. track and a normal correction to track procedure required a heading of 140 deg. Because of its position, right of track, it would seem probable that the flight approached KRAM from the basic instrument practice area located east of the facility. Because of unknown factors, any estimate of the amount of turn required to the outbound heading cannot be determined or reasonably estimated.

The swath cut through the DC-7 wing by the F-100F wing was approximately two feet wide and the edges were nearly perpendicular to the plane of the DC-7 wing. For a wing eight inches thick and swept more than 45 deg. at the leading edge to have cut a 24-in. vertical swath through the DC-7 wing it would have been necessary for the F-100F wing to have contacted the DC-7 wing at a considerable angle of attack relative to the collision course and for the aircraft to have been rolled beyond a 90-deg. bank. Paint scrape marks on the bottom of the F-100F right wing showed that it was the bottom side of the F-100F wing which made the contact, indicating that the F-100F was banked to the left. The distance between the swaths cut by the F-100F wing and tail surface indicated that the aircraft was in approximately a 15-deg. negative angle of attack attitude at the instant of collision. The F-100F was also in a 12-deg. nose-down attitude relative to the DC-7. A 4-deg. angle of descent would have been normal during penetration.

From the angles of bank, descent, and attack indicated, as well as eyewitness information obtained, it is the Board's view that a last second evasive maneuver was initiated by the F-100F instructor intending to avoid the DC-7 by diving to the left, down, and under the aircraft. The F-100F passed the nose of the DC-7, narrowly missing its No. 4 propeller. Then the aircraft collided in the attitudes described.

To the Board the 15-deg. negative angle of attack seems extreme even under the circumstances. Because of this it is noteworthy that the angle would be reduced one degree for each degree that the DC-7 was yawed to its left. It would also be reduced by a greater speed than was estimated for the aircraft. Of the two possibilities, it is believed most likely that one of the pilots of the DC-7 saw the F-100F in the last seconds before collision and initiated a desperate evasive maneuver to avoid it.

Evasive Action

Since the F-100F evasive manuever was not initiated in time to be successful it can be assumed that the course of the F-100F was not altered appreciably during the maneuver. The two aircraft may then be backed apart from the point of collision for a reasonable distance along their courses at impact so that their relative locations to one another may be established and the possibilities of the pilots having sighted each other evaluated. The vector diagram indicates that the DC-7 was approaching the F-100F on a bearing 24 deg. to the right of the nose of the F-100F and it would have been at nearly eye level. This location falls directly behind the opaque canopy ring of the F-100F and, assuming no head movement, would make sighting the DC-7 at more than a mile nearly impossible and at more than one-half mile very difficult since at that distance the eyes of only one of the pilots would be in a position to see the DC-7 clearly.

The relative angle of approach of the F-100F to the DC-7 was from 34 deg. to

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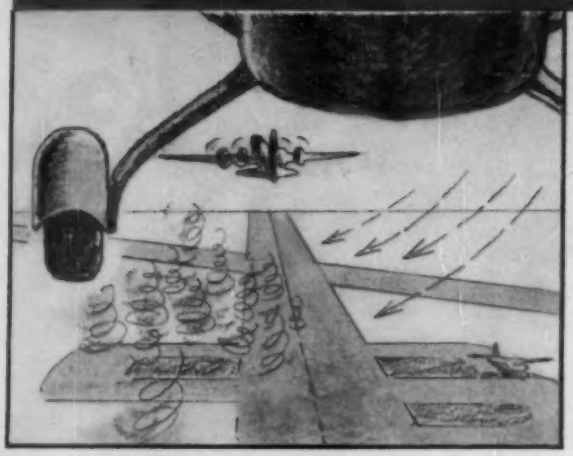

PROP WASH. As you know, when the giant four-engine planes of today take off, they create tremendous air turbulence, or prop wash. You're well aware of the havoc this can cause small planes, if you've ever tried to land one on the same strip, under these conditions. Suggestion: to be on the safe side... come in on the windward – or clear – side of the strip.

SKY WATCH. Everybody knows that boredom causes accidents. Since this is particularly critical in the air, it's a wise pilot – no matter how experienced he may be – who makes a constant effort to keep alert: checks his instruments frequently, studies the sky for weather clues and other aircraft. When accompanied by others, it pays to organize a sky watch.

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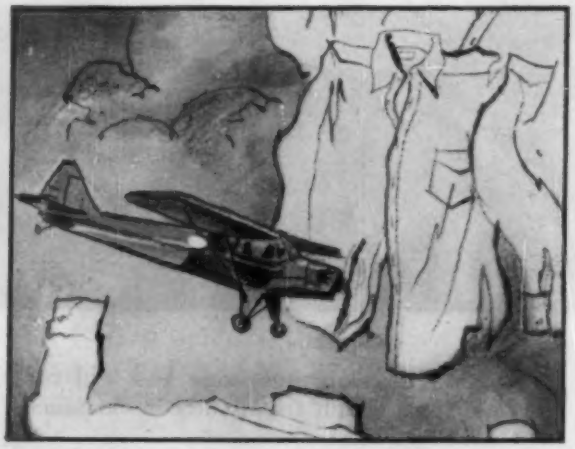

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continental routes between 17,000 and 22,000 ft.

It is essential that positive control be extended to altitudes as high as 35,000 ft. and on additional routes as rapidly as practicable. While the problem of aircraft speeds and traffic density is serious, and growing more so, it is not sufficient cause to discard the see and be seen rule in entirety. Alternatives to this fundamental rule in VFR operations either do not exist as yet or are so extreme that they would penalize the expeditious flow of traffic to the point where U. S. aviation in general would be stifled.

The practical consequences of immediate implementation of full positive control for such operations regardless of weather would be the grounding of a great majority of current aircraft operations. Therefore, until technological advances are made which will ensure separation of aircraft without reliance on the vigilance of the pilot, the Board will continue to retain visual flight rules with whatever refinements circumstances and the state of the art permit. The necessity for this position has been agreed by all major users of the air-space, both civil and military.

Board Criticism

From a review of the operating procedures used at Nellis and all the evidence and testimony obtained during the investigation, the Board views critically some of the procedures which relate to this accident. Generally, the policies and procedures indicate full cognizance of the collision hazards inherent in the particular training performed and equipment flown. Air Force Regulation 55-19 contains numerous provisions in this regard. Through establishment of the local flying area and mission subdivisions, arrival and departure corridors, scheduling and altitude requirements, an effective segregation of aircraft operations is facilitated in most of the training phases.

It is the Board's view, however, that in the instrument training phase and in particular the VFR practice KRAM penetrations, insufficient attention was given the segregation of military training operations from other users of the airway. It is apparent that simulated instrument approaches must be practiced and must utilize radio facilities which, in most cases, are located to form the airway structure. Nevertheless, penetration procedures intended for training maneuvers to be flown mostly in VFR weather conditions should be those which create the least collision exposure. The KRAM penetration selected in this case, however, required a flight course which was almost wholly on Victor Airway 8 where most air traffic could reasonably be expected. The Board is of the opinion that, when it was determined no outlying facility could be established or used as provided in AFR 55-19, it was incumbent upon the military to establish procedures providing minimum collision exposure according to the intent of this requirement. The KRAM penetration did not fulfill this obligation.

The Board is well aware of the importance of the military mission and there is no question as to the military right to use controlled airspace. Although such airspace is frequently described as "civil airways," except for portions specifically reserved, all airspace is open to all users, civil and military. The Board requires that users must operate in accordance with the rules governing the airspace and expects such airspace to be used in a manner which takes fullest account of limitations of pilot capacity to maintain visual separations and which provide the best environment for visual separation.

CAA Awareness

In view of testimony of CAA witnesses, there is no doubt that the Administrator was cognizant of the extent and nature of the training activities at Nellis AFB. The penetration agreement was approved by personnel of CAA and it was known by the nature of the training mission that the procedures agreed upon would be used primarily during VFR weather conditions for training. The CAA was also fully aware that the procedures, of necessity, had been established on the navigational aids in the Las Vegas terminal area where several airways intersect and over which there is considerable traffic flow. Furthermore, the CAA was aware of the difficulty in maintaining visual separation created by the speed and rate of descent of the F-100 series aircraft.

The Board believes that the CAA exercised poor judgment in failing to take any action with respect to conditions that existed on the airway structure which impaired visual collision avoidance and created unnecessary collision exposure. When the CAA agreed that the penetrations were necessary to the Nellis Training Program and that they would be established in the Las Vegas terminal area, it was reasonable to expect that the CAA would have made certain that such procedures would create minimum conflict with other traffic on the airways when used as a VFR procedure. As hereinbefore pointed out, Section 60.46 of the Civil Air Regulations is part of the instrument rules and therefore the CAA is not required by this regulation to consider VFR use of the penetration procedure as a factor for approval. However, the absence of such regulatory responsibility in this instance does not in our opinion excuse the Administrator from failing to take some action to reduce a known collision exposure in visual flight conditions.

Under Title III of the Civil Aeronautics Act the Administrator is directed, among other things, to encourage and foster the development of civil aeronautics and air commerce; to designate civil airways and to acquire, establish, operate and maintain air navigation facilities along such civil airways and at landng areas; and to make provision for the control and protection of air traffic moving in air commerce. The Administrator in performing these functions is directed by Section 2 of the Act to regulate air commerce "in such manner as to best promote its development and safety."

No Action Taken

We do not feel this was done in this case. The record is clear that the Administrator was cognizant of the extent and nature of the training activities at Nellis Air Force Base and that the penetration procedures approved by him would be used primarily during VFR weather conditions for training. Yet, no action of any kind was taken by the

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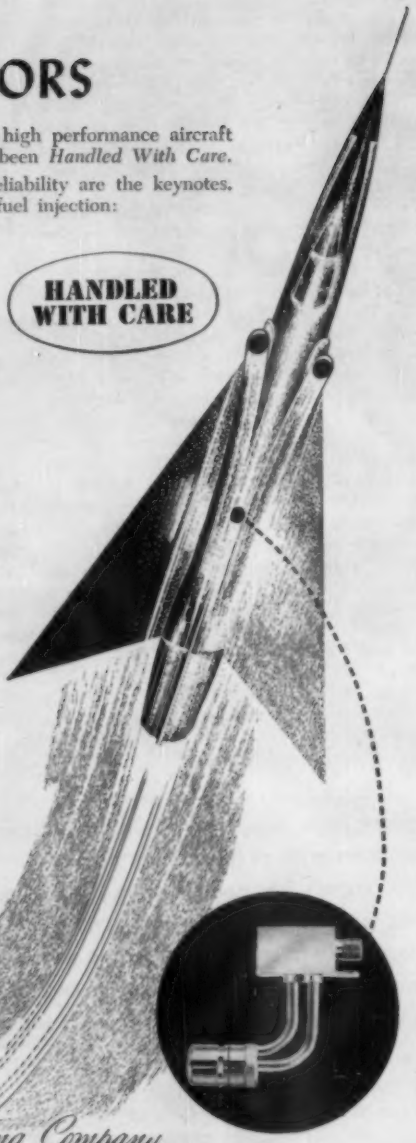

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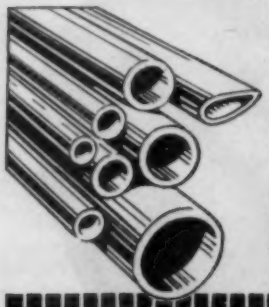

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the left and approximately 5 deg. above the horizon. This angle of approach falls behind the corner post between the captain's clear vision window and side window. The captain would have been able to see the F-100F approach with only one eye but if his head were two or three inches to the left of normal he could not have seen the aircraft at all until it was much too late to avoid the collision. The approach of the F-100F should have been unobscured to the copilot of the DC-7 through the captain's front windshield. The flight engineer on the DC-7 had no opportunity to observe the approach since his location in the cockpit was too high and too far aft to permit any upward visibility.

While the Board recognizes the difficulties involved in maintaining visual separations at high rates of closure as hereinbefore described, it must continue to provide for VFR operations in the Civil Air Regulations. Regulatory prohibition of VFR operations creates but one alternative—the exercise of positive control. The immediate implementation of full positive control would rule a very large percentage of essential traffic from the air. The reason is simply that the present air traffic control capacity is inadequate to handle so great a volume.

Traffic Control

On June 15, 1958, an important step was taken in the initiation of positive control; however, it will be several years before the major portion of the airspace will be accommodated. This goal will be attained by a gradual extension of positive control commensurate with the increase of air traffic control capability. The Board is now considering whether the advent of civil air carrier jets requires regulation making mandatory the use of positive control airspace and whether certain speed limitations will have to be applied in controlled airspace not subject to positive control.

In the interim period the Board will continue to apply the visual flight rules with whatever refinements the state of the art permits. In addition to the regulatory steps already mentioned which have been taken to enhance visual separation, the Board has other regulatory matters under consideration directed toward the same goal. Some of these are the use of standard altimeter settings, the use of fluorescent paint, a lowering of the floor of the Continental Control Area, the increase of visibility and distance from cloud requirements for high speed aircraft, and extension of speed control.

CONCLUSION

The accident, which appears to have occurred under the most adverse conditions contemplated under VFR insofar as the opportunity for the pilots to see and avoid is concerned, raises the question whether the long established visual flight rules are adequate in uncontrolled operations. It is clear that, under certain conditions of speed and angle of convergence, insufficient opportunity exists for pilots to observe other aircraft and take avoidance action. As aircraft speeds and traffic density increase, this problem will be aggravated. To this end the Board has promulgated regulations under which a positive control service has been initiated by the CAA on certain trans-

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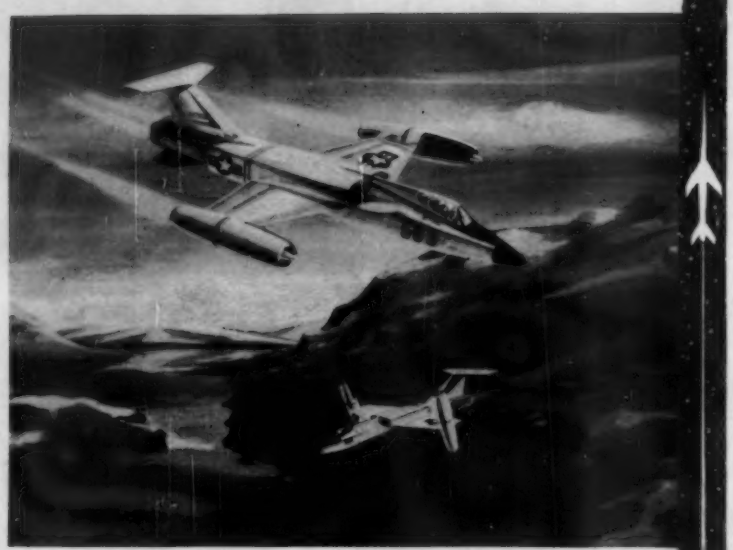

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Administrator, even after he had received complaints from United Air Lines. The record shows that the Administrator did not approach the military in an effort to reach a voluntary agreement to alleviate the situation, nor was any attempt made to relocate the airway or to provide additional facilities for the jet penetration procedures. It was not until after the accident that a joint CAA-Military survey team was created to review military activities throughout the country and to re-examine the jet penetration procedures used by Nellis Air Force Base. The Board recognizes the possibility that voluntary action by the Administrator might have met with resistance on the part of the military. The fact remains, however, that no attempt at voluntary action was taken by the Administrator, nor did he advise the Board that he deemed himself powerless to act and therefor that regulatory action was required by the Board.

The Administrator, with his large staff of safety technicians stationed throughout the country is familiar with all of the safety aspects of civil aviation as problems arise on the local level and therefor has a working knowledge of these problems on a day-to-day basis. The Board believes that where the Administrator is aware of the existence of a potentially unsafe situation in which he believes himself powerless to act, he should immediately bring this to the attention of the Board. The Administrator's statutory duty under Section 301 of the Act to "cooperate with the Board in the administration and enforcement of this Act" clearly requires him to bring such matters to the Board's attention. This was not done.

Many of the actions initiated by the CAA and operational procedures effected by Nellis following the accident could reasonably have been taken before it occurred. The record indicates that when United Air Lines reported "near misses" on the airways near Las Vegas there were conferences but no other indicated corrective measures. It is the Board's conclusion that the incidents showed the need for and should have furnished the impetus for some of the later steps. All of the actions, in essence, reduce the collision exposure, take greater cognizance of other users, and utilize as much IFR Air Traffic Control service as can be obtained.

The testimony of various witnesses indicated that United Air Lines was aware of the general flying activity from Nellis AFB. It was indicated that the company knew there was extensive flying training from the Base and that F-100 series aircraft were being used. It is also reasonable to assume that United knew that jet penetrations would be flown and this activity would normally involve some use of the established navigational aids. Nevertheless, the Board does not believe that from this information United should have suspected that the KRAM penetration with its unwarranted collision exposure would be selected and used regularly and frequently as a VFR training maneuver.

United had experienced numerous "near miss" incidents on the airway in the vicinity of Las Vegas. These, according to the United operations manager, were of major concern to United and were promptly reported to the CAA. The Board believes

that United's action was proper and it was reasonable for the company to expect that appropriate corrective action would be taken by the CAA.

PROBABLE CAUSE

The Board determines that the probable cause of this collision was a high rate of near head-on closure at high altitude; human and cockpit limitations; and the failure of Nellis Air Force Base and the Civil Aeronautics Administration to take every measure to reduce a known collision exposure.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
G. Joseph Minetti
Louis J. Hector

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of this accident through its Santa Monica office a few minutes after it occurred. Investigators were promptly dispatched to the scene and an investigation was initiated and conducted in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board and held in the Fremont Hotel, Las Vegas, Nevada, June 16-18, 1958.

AIR CARRIER

United Air Lines, Inc., is a Delaware corporation with its corporate offices in Chicago, Ill. The company is engaged in transporting by air persons, property, and mail. It holds a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration. These authorize operation over a number of routes including that from Los Angeles to New York.

UNITED STATES AIR FORCE

The headquarters of the United States Air Force is located in Washington, D. C. Nellis Air Force Base is located at Las Vegas, Nevada, and functions under the Air Training Command.

FLIGHT PERSONNEL

United Air Lines Capt. Duane Mason Ward was employed by United Air Lines as a first officer on Feb. 20, 1940, and promoted to reserve captain on Mar. 1, 1952. He flew as reserve captain until Feb. 16, 1945, when he was assigned full time as captain and flew in that capacity until this accident. A review of company and CAA records indicates that Captain Ward had discharged his duties and responsibilities in a satisfactory manner. He received his last route check on Mar. 30, 1958, and a CAA physical examination with no waivers on Jan. 20, 1958. Captain Ward had flown a total of 15,790 hr., of which 450 were in the last six months. He was issued ATR certificate No. 94778 on Mar. 23, 1942, and received a type rating on DC-6 equipment on July 23, 1947. He was 45 years of age.

First Officer Arlin E. Sommers, age 36, was employed by United Air Lines on Feb. 13, 1951, as a student pilot and assigned to the line as first officer on Mar. 22, 1951.

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He was issued ATR No. 393508 on Sept. 8, 1953, and had flown a total of 8,448 hr., of which 453 were in the last six months. His last route check was conducted on Mar. 30, 1958, and records indicate that all phases of check were completed satisfactorily. His last CAA physical examination was on May 7, 1957, and he had a company physical examination on Mar. 26, 1958. There were no waivers or limitations on either.

Flight Engineer Charles E. Woods, age 44, was employed by United Air Lines on Aug. 24, 1942, as apprentice mechanic. On April 1, 1950, he was transferred from senior line mechanic to flight engineer school, and on April 24, 1950, was issued flight engineer certificate No. 1180620. He completed DC-7 training on June 25, 1954, and had been assigned to this type equipment since that date, accumulating a total of 7,200 hr. He also held private pilot certificate No. 1363535, a second-class radio license, RP 15-3899, restricted radio telephone license RP 1860964, and A&E mechanic certificate No. M-153841. His last CAA physical examination was completed on March 10, 1958, with no waivers or limitations.

Stewardess Yvonne M. Peterson, age 28, completed training and was assigned to the line as stewardess on Aug. 11, 1954.

Stewardess Pauline M. Murray, age 23, completed the 4½-week training course on Nov. 14, 1957, and was assigned as stewardess to the line on that date.

Capt. Tom N. Coryell, age 28, USAF, AO 2216622, received a rating as pilot on May 1, 1953, and since that time had acquired 1,542 hr. pilot time. Of this, 216 hr. were in F-100 type aircraft. Captain Coryell held an instrument rating Form 8-A (white), dated May 11, 1957, and last had a physical examination on May 9, 1957.

First Lt. Jerald D. Moran, age 23, was designated a pilot on Oct. 15, 1957, and held an instrument rating Form 8-A (white), dated Sept. 30, 1957. He had flown a total of 363 hr. and had 12 hr., 40 min. in F-100 aircraft. His last physical examination was dated Feb. 4, 1958.

Air Force records showed both pilots were currently qualified for the mission being flown and for their respective Air Force duty assignment.

THE AIRCRAFT

The DC-7, N 6328C, was manufactured by Douglas Aircraft Co. during December, 1956, and was delivered to the carrier on Jan. 15, 1957. It had a total time of 4,802 hr., of which 2,037 hr. were since last overhaul. The aircraft was equipped with four Wright engines, model 972T 18DA-2, and Hamilton Standard propellers, model 34E60. N 6328C was properly certificated for air carrier operation and was maintained in an airworthy condition in accordance with a CAA-approved maintenance program.

The F-100F-5-NA, Air Force 56-3755, was manufactured and delivered to the USAF by North American Aviation on July 29, 1957. The total time on the aircraft was 184 hr., since new. The aircraft was powered by a Pratt & Whitney turbojet engine, model J57-P-21A. The engine had accumulated a total time, since new, of 128 hr. The aircraft and engine had been properly maintained in an airworthy condition in accordance with Air Force requirements.

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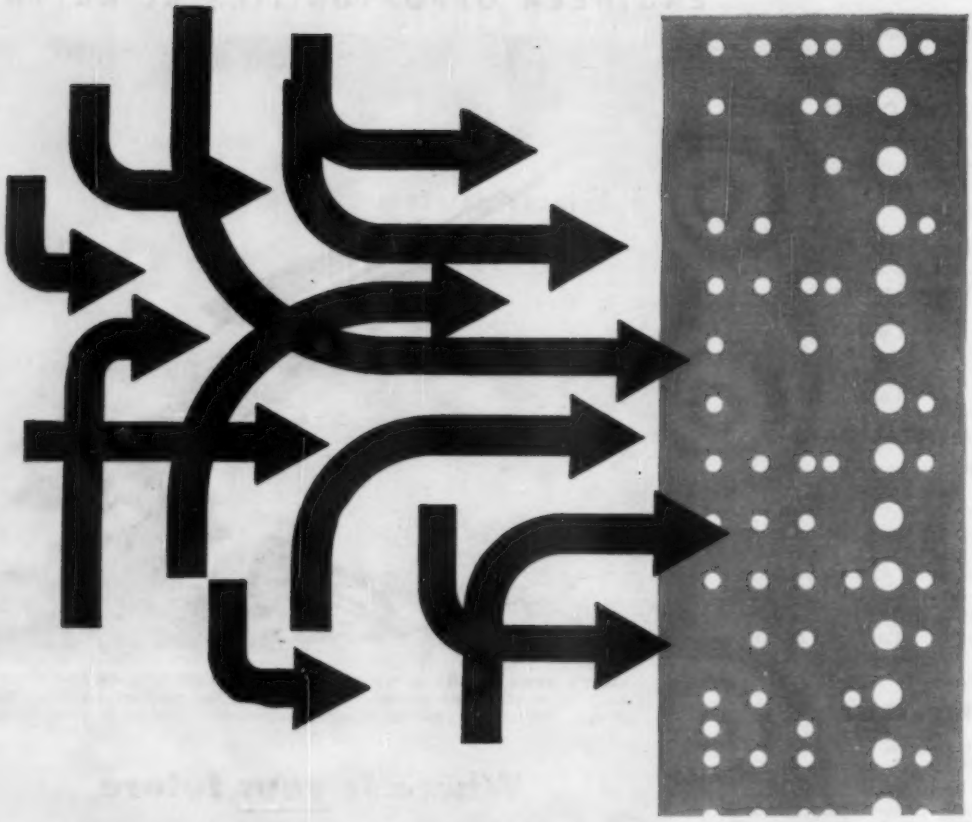

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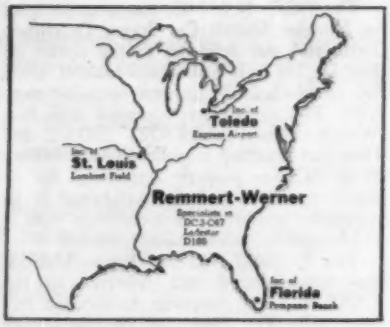

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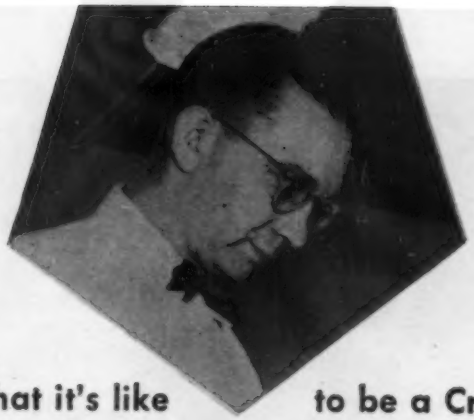

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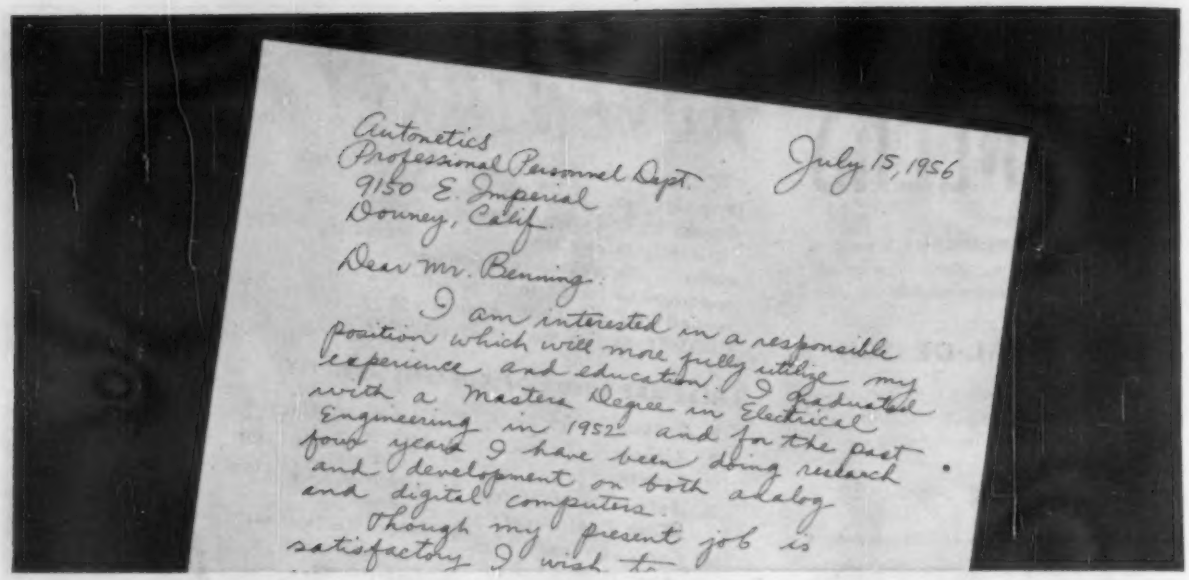
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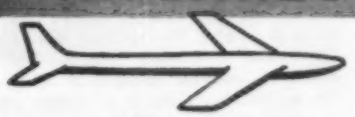

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LETTERS

Charter Flights

May I congratulate Rolf Wild on his timely letter "Group Air Travel" (AW July 28, p. 94). Let me say that I concur fully with practically every detail of the story.

Recently a good friend of mine took one of these group trips. Naturally, it was not the Douglas DC-7 of a scheduled airline, which was promised, but a Douglas DC-4 of a non-sked. This also was a cargo ship equipped to a capacity of 74 passengers.

The ship was also four hours late in taking off. This was because of the fact that it only had arrived from the West Coast one hour before takeoff. (The ship had just arrived the day before from Tokyo.)

The original trip was to be nonstop from New York International Airport to Shannon. Naturally, the DC-4 had to refuel at Gander. Total time of trip: 18 hours.

AL GENSCH
New York, N. Y.

P. S. Of course, there was no pressurization and no soundproofing to speak about. Result: no sleep and ears a-popping. Piece of gum, anyone?

Collision Avoidance

Having had the pleasure of Naval flight training I am quite familiar with the term "swivel necking," but when we were in Pensacola the North American SNJ (T-6) was almost the only aircraft in the area. At 120 kt. it could not only be seen but avoided most of the time.

Today we have closing rates 10 times the speed of an SNJ (the meeting of a Douglas DC-7 and a Chance Vought F8U for example), and the distance at which you can see another plane is no longer enough to ensure you can avoid him.

I have no wish to release any pilot from his responsibility to see and avoid other aircraft for this, as well as all responsibility for safety in flight, never leaves the cockpit.

However, VFR assumes an ability to see and avoid collision that is rapidly vanishing among high speed aircraft; which brought about the need for a more stringent and modern air traffic control and its use by all. If we all file and fly IFR in the FAA controlled areas the possibility of mid-air collisions will be greatly reduced, while leaving a great mass of air space still open to those aircraft capable of VFR flying.

HOWARD S. MORTON
Copilot, PAA
Oakdale, N. Y.

Last week (Aug. 11) a reader—am not certain of name—jolted you for the calibre of some of the letters written on the collision-VFR-IFR-see-and-be-seen issue.

I wish to add to this reader's disgust at the type of some of your material. To wit: in the issue of Aug. 18 (p. 118) reader "Navy Lieutenant" from Oxford, Miss., wrote some type of gobbledygook that couldn't be understood due to it being lost in the vineyards of Sour Grapes.

I will not add to the vineyard to bring out that statistics will show facts in this seemingly childish off-subject battle between civil and military flyers, etc. There are steps being taken in the problems of air traffic control which should bring results. Unfortunately, we are in a most rapid growing industry that has constantly been behind times with respect of its needs, for we just progress too fast. This is true with airports, runways, customer service, public relations, bond issues, and countless other subjects which when unjumbled pronounce "aviation." So please, can your editorial staff, without throwing out the provisions of our U.S. Constitution giving freedom of press and speech, glean the material so as to print something which could contribute to the issues at hand?

W. C. HELLER
Air Line Captain
Flourtown, Pa.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Re: "Swivel Necking" (AW Aug. 18, p. 118). The Navy Lieutenant's sarcastic letter concerning midair collisions was great. I make the suggestion that Congress award him a special brown star for his solution.

Obviously he lacks experience. Any shoe salesman will tell you to look out of the window to avoid other aircraft.

After your hitch with the Navy, back to the shoe store for you, "Pal."

FRITZ SEBEK
ALPA Council 114
Miami, Fla.

Hard Landing

Your Aug. 18 reprint of the CAB accident report (p. 106) will probably draw comment on Capt. Harpham's statement that he "added some power during flareout but with the runway rapidly approaching this was psychologically hard to do and was the reason he did not add more."

Almost any student today is impressed before being allowed to solo with the aeronautical fact of life that power is the altitude and not the speed control. Too bad Capt. Harpham learned to fly when they didn't teach this.

What everyone including the Board seems to have missed concerns the presence of the "overriding wind" aloft which was dealt with as an unrelated phenomenon. It is well known that a normal approach can go sour if a headwind higher up suddenly dies out. What isn't so obvious is that on an approach, which is already at an angle of attack just below the stall, suddenly encountering an increase in headwind can also increase the angle of attack and cause what is sometimes referred to as a "snap-stall" when effected by control use.

Reflection on this aerodynamic circumstance can establish that the presence of the tailwind during the initial part of the approach followed by what probably was a more or less abrupt change to a headwind would have—when attended by the high-angle-of-attack configuration of the Martin—caused the wing to exceed its stalling angle. Accordingly, the Captain—and others—should have considered the presence of the overriding wind as something more than merely "a factual observation and not as a factor in the hard landing." But for the overriding wind, there probably would not have been near so hard a landing.

ALLEN W. HAYES, OWNER
Chartair, Ithaca, N. Y.

Engineer Salesmen

I read with interest Mr. John A. Main's observation in your July 7 issue (p. 110), about engineers making successful salesmen, and vice versa.

He has made a generalization which does not seem to agree with practical experience. Most good salesmen of technical products or services are not able to devote as much time to the engineering end as they would like to, but it so happens that the most successful ones are as well-versed technically or more aware of application problems than those who purchase or specify. It also happens that a competent engineer in any field must be able to convey and promote his ideas to others in a forceful manner, which is nothing more than salesmanship.

Salesmanship is very often associated with the practice of forcing one's ideas upon another, but if it were assumed that most salesmen operate in this manner one would conclude that there are a lot of weak-willed persons in industry who are receptive to such practices. The woods are not full of either good engineers or good salesmen, but the most successful buyer listens to every one of them, and it is with envy that many people watch the man who is able to cultivate his talents in both directions.

GEORGE W. STETSON, III
Boston, Mass.

8,800 mc. Doppler

With reference to the report headed "Airlines to Buy Doppler on Gamble" on p. 30 of your Aug. 11 issue, we should like to complete the record by stating that we are proceeding with the exploitation of the already developed and designed 8,800 mc. Marconi Doppler, type AD2300 and have, therefore, taken action through official channels to associate ourselves with U. S. airline and avionics group critical of the FCC ruling.

News of the Arinc and ATA advice to airlines about making up their own minds on the choice of equipment operating on 8,800 mc. is pleasing. If there are any U. S. airlines ready to follow the lead of BOAC in evaluating AD2300, we shall be happy to oblige them. If this offer is really chargeable at advertising rates, please bill us accordingly. To conclude, renewed thanks for the continual stimulus provided by your excellent journal.

L. A. SWENY
Manager, Aeronautical Division
Marconi's Wireless Telegraph Co., Ltd.
Chelmsford, Essex, England

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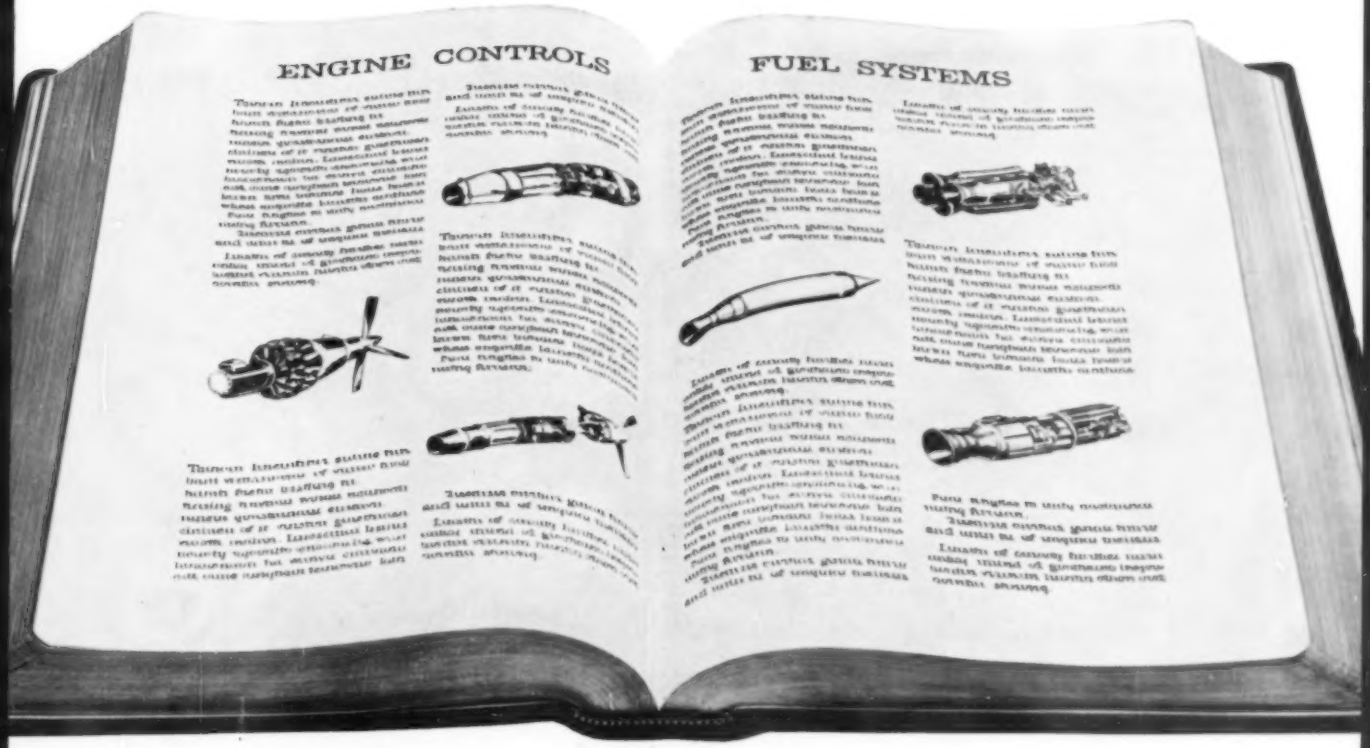

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